SCIENTIFIC AMERICAN SUPPLEMENT. No. 1336

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Scientific American. established 1845.
Scientific American Supplement. Vol. LII. No. 1336. NEW YORK, AUGUST 10, 1901. Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE "SANTOS-DUMONT No. 5" CIRCUMNAVIGATING THE EIFFEL TOWER.—Reproduced from a photograph.

THE "SANTOS-DUMONT NO. 5."

The first fifteen days of July, 1901, have been signalized by two great events which may well be said to make two red-letter days in the history of the world, and in each case the conquest has been one of science, and so far, the Twentieth Century has proved itself in no way inferior to the Nineteenth. Within an interval of only ten days the submarine boat "Gustave Zédé" has made wonderful trials in Corsica, remaining hours under water, and the dirigible balloon of M. Santos-Dumont made a most successful flight at Paris.

The balloon of M. Santos-Dumont, which made a trip from St. Cloud to the Eiffel Tower and return, is the fifth aerostat which this very clever young Brazilian engineer has constructed, to solve the problem of dirigibility. He was inspired by the works of his predecessors, particularly by those of M. Giffard and of MM. Renard and Krebs. M. Santos-Dumont uses for his source of power a petroleum motor, light and powerful, of the Dion-Bouton type, so much employed for automobiles. On September 18, 1898, he launched the "Santos-Dumont No. 1," driven by a motor of this kind, and since that time he has not ceased to experiment and perfect his plans for aerial navigation, and his last venture has proved highly successful. The balloon is cylindrical and is covered with silk, the extremities being pointed. It is 111 feet long and its capacity is 19,300 cubic feet. Suspended some 35 or 40 feet below the balloon proper is a light framework whose profile very much resembles that of the balloon proper. The section of this framework is triangular. It is formed of three long pieces of wood secured together at the ends and strengthened by cross-bracing. Steel wires also assist in preventing the framework from being deformed by strains. The framework supports a four-cylinder 16 horse power motor, the fuel reservoir, the shaft and the propeller. The engine is placed well toward one end and the aeronaut rides in a light basket toward the other end. Here he has under his control all of the machinery for maneuvering the balloon, also the ballast and the guide-rope. The respective positions of the various weights have only been determined after many experiments. Its equilibrium is perfect, and this assures its horizontality and an equal tension on the suspenders. This explains why the aeronaut is so far separated from his motor. The framework is attached directly to the balloon by a system of strong piano wires which offer no resistance to the wind. The wires cannot be distinguished when the balloon has attained any altitude. The propeller is 14 feet in diameter and is composed of two wings of wood and steel, covered with silk and highly varnished. It attains a speed of 150 revolutions a minute. The steering device, or rudder, is of silk and is placed between the balloon and the framework, and above the propeller. The balloon is inflated with hydrogen, and in order to maintain at all times a tension on the envelope, that is to say, a perfect inflation, a compensating balloon filled with air is placed in the interior. This is inflated automatically, as required. A small compressor actuated by the motor serves to give the necessary pressure in the small internal balloon, to which the air is conducted by tubing.

An 80-pound guide-rope is suspended under the framework. With its aid the necessary inclination is obtained to effect the movements of ascent or descent. Such, in brief, are the apparatus and methods employed by M. Santos-Dumont.

The aeronaut made his remarkable journey on the 12th of July, starting at 3 o'clock in the morning from the park of the Aéro Club at St. Cloud. The guide-rope was held by the workmen until the race-track at Longchamps was reached, and there the balloon was cast off. There was no difficulty in obtaining an altitude of 500 to 700 feet. The balloon turned around several times, and then M. Santos-Dumont took a tour of the Bois de Boulogne and came back to his point of departure. Encouraged by his success, at 7 o'clock the following morning he turned toward the Eiffel Tower, but owing to the height of the garden of the Trocadero he was obliged to stop to repair a part of his rudder. He then doubled the Eiffel Tower and returned to St. Cloud without accident, after a trip whose duration was more than an hour. The next day an attempt was made to obtain the prize of 100,000 francs offered by M. Deutsch in favor of the first aeronaut who started from St. Cloud, doubled the Eiffel Tower and returned to the starting place in thirty-five minutes.

At a quarter past 6 in the morning, the balloon was got ready and inspected and a quarter of an hour later M. Santos-Dumont was in the basket, the motor was started, and the balloon commenced to rise. The exact time of the start, which was made in the direction of the Eiffel Tower, was 6:41, and everything seemed favorable for a good voyage. There was a light wind from the northward, which obliged the aeronaut to describe a large circle. Another cause of delay was that the motor worked unsatisfactorily, only three cylinders working in place of four, which, of course, rendered the speed defective. At 7 o'clock the "Santos-Dumont No. 5" doubled the Eiffel Tower just above the second platform. This evolution was accomplished with remarkable precision. The return was not so successful, owing to the continued trouble with the motor, and so much time was lost that it was impossible to claim the prize. The balloon had the same difficulty in returning to the balloon-house, the trouble this time being caused by some new sheds which had been constructed. The aeronaut decided to descend at Longchamps, and he recrossed the Seine, but the motor worked worse and worse, so that nothing remained but to descend. The balloon was deflated, and the guide-rope caught in the branches of some trees on the property of M. de Rothschild. Happily the aeronaut was not injured and the balloon was only slightly hurt. The damage was immediately repaired, and on July 29 M. Santos-Dumont made another ascent. He had arranged to make his promised trip over Paris in the afternoon, but he was obliged to abandon the idea, as he found that the motor was working badly. Still, in order not to disappoint the numerous visitors to St. Cloud, he gave a maneuvering exhibition over the Bois de Boulogne. Several ascents were made and the guide-rope frequently caught in the trees, but it was released without any harm being done. All the visitors were astonished by the marvelous control the inventor had over the balloon. The weather was favorable and there was no wind. The motor was obviously at fault, as the screw was frequently at a standstill. For our engravings and the foregoing particulars we are indebted to L'Illustration.

AN UNIVERSAL ALPHABET.

By J. C. Ruppenthal, LL.B., Russell, Kan.

In the National Review of a few months ago, the Chinese Minister to England, Sir Chihchen Lofengluh, in a thoughtful article, said: "The world is in want of a universal written language," and after adding that we are drifting to the Chinese way-symbolic language, adds: "For whether you know it or not, or wish it or not, you are drifting toward a universal language in obedience to the law of evolution." About the same time the American journals stated, as a news item: "There is now a conference of a European Academy of Science at Wiesbaden on the possibility of all nations adopting a uniform scientific and commercial language. They favor Latin for scientific and English for commercial use." A few years ago the students of Volapük had high hopes that their exact, scientific language would soon be *the* world-language that every person of average intelligence would know in addition to his mother-tongue.

In this age of electric communication and rapid transportation the "wide, wide world" of old has shrunken to inconsiderable bounds and all men are neighbors. The events of the last three years have brought this home to the American people as never before. The close inter-relations of the peoples of

M. SANTOS-DUMONT.

every part of the globe, and more especially our wider sphere in the Orient, as well as in the Antilles, have given us renewed interest in the matter of universal speech and impressed us with its importance and desirability to the diplomat, the statesman, the soldier, the merchant, the missionary, the traveler, and the scientist.

It is not lack of appreciation of an universal tongue—written, spoken, and understood everywhere—that has prevented Volapük and similar artificial languages from coming into general use. At least one reason may be found within the very name—*Volapük*. Here is an aspirant to the throne of the world, yet what is its name? No person whose mother-tongue is English, can tell, until he has been taught the pronunciation of the word *Volapük*. At the very threshold of the study, here was a great stumbling-block. With six sounds represented by *o*, seven by *a*, and five by *u* in our language (and the ü umlaut totally foreign), the first requisite in learning the new speech was to find out definitely the phonic values of the letters used. There are 252 possible pronunciations of the letters, v-o-l-a-p-ü-k, and 756 if the accent be varied.

The investigation of the principles of a progressive movement sometimes reveals the need of a primary reform to which the investigated movement is but secondary. Thus it appears that in attempting to establish an universal language, the beginning should be with the elementary sounds used in human speech, and the characters or letters representing such sounds. A simple, scientific, universal alphabet is needed in the making of an universal language, or the reformation and simplification of those existing. English, with its 26 signs used to represent from 40 to 45 different sounds, has especial need of an universal alphabet to simplify it and to extend its use, whether in Cuba, Luzon or elsewhere.

An universal alphabet should be based on the principle of representing each sound by a single sign which should stand for one (and only one) simple elementary sound. Every sound made by the human voice and used, either alone or combined with other sounds, to express an idea, should have a character to represent it. Into such an alphabet all written languages, whether living or dead, could be transliterated. The dialects of unlettered races would find in this a written and printed form to meet every possible demand. No further sets of arbitrary characters would need to be devised, as has been done for the American Indian, African and South Sea tribes. To the aborigine, or to him whose vernacular is a local dialect, the universal alphabet would be as acceptable as though designed for his especial use, while to the scientist it would be an incalculable saving of valuable time and effort if he were not obliged to learn a new alphabet for each race or tribe. It may be remarked parenthetically that Prof. Richard T. Colburn, in his lecture on "Improvident Civilization," places diversity of languages among the "eight great wastes of vital force in our times."

The adoption of Occidental ways by the Japanese and the constant inroad of Western ideas in China—whether dismembered or intact—make it probable that the word-sign method in vogue among Mongolians will be superseded by something less complex. Will it be English?

The vast numbers of people who speak English, estimated to-day at 130,000,000; their wide dispersion over the globe; their extensive literature and numerous periodicals; the ceaseless advance of their speech over new territory and its adoption by ever-increasing hosts, place this once-insular language at the head in the march for universal lingual dominion. But even Chauvinists on the subject may see that this dream of supremacy is far from realization unless the illogical spelling of English—the quintessence of absurdity—is changed. The ghosts of departed sounds that now troop along as silent letters in most English words, the many characters and combinations standing for one sound, and the many sounds represented by a single letter, may be insuperable obstacles to the speedy acceptance of English by other nations. The New York Press said about two years ago: "English is becoming the language of the commercial world. China, Japan and Mexico have lately taken it up in the schools." (Now we must add Cuba, Porto Rico, and the Philippines.) "The queer and sometimes awkward features of English orthography are the only blocks to the general acceptance of our tongue in commercial dealings." At present an English speaking child must first learn a quadruple alphabet, consisting of capital and lower-case Roman letters, and large and small script—104 different characters which must be recognized at first sight—to say nothing of italics, black-letter and display type. The doorway into the temple of learning is almost choked with rubbish which even the smallest toddlers must climb over, or

"Knowledge to their eyes her ample page,
Rich with the spoils of time, will ne'er unroll."

The student now finds ten or more standard English dictionaries. In each he needs to learn a key to pronunciation—really a new alphabet—before he can freely and fully use the work.

A scientific universal alphabet would remedy all this, and from the outset would be the standard of pronunciation in all dictionaries of every language, until such time as the language itself (where written) would be transliterated, needing no indications of proper pronunciation other than the simple (universal) letters composing the word. To-day our newspapers and magazines rarely indicate the pronunciation of new words—even before they are generally added in supplements to dictionaries—because this cannot be done except in a roundabout and unsatisfactory way. As soon as a universal alphabet is adopted by representative scientific bodies, or authorized by law, or both, fonts of the new type will be found in almost every printing establishment, as italics now are, and linotype machines will be built to meet the new demand. First, the new alphabet would be used in the public prints for pronunciations, foreign proper names, etc. Then it would be taken up for international correspondence, for names of ships, for signboards of railway stations, streets in large cities, etc. It would speedily be used in international publications like those of the Bureau of American Republics.

It may be said further that the English-speaking student, after mastering 104 letters in his own language, besides numerals and marks (punctuating, diacritical and arbitrary) is still among the breakers near shore, if he incline to linguistics. For each European language that he takes up, he must learn another double alphabet for reading, or quadruple, if writing be added. This is true even when the Roman letters are used, for their phonic value is different from that given them in English. The Oriental languages are yet more difficult and complicated.

The objection that any change of alphabet—or of spelling, perhaps—will render the vast accumulations of literature, especially English, as difficult of access as if now in a foreign tongue, is met by the reply that the progress of printing is such as to insure the prompt publishing in the new way, of all that is valuable at least, whatever alphabet or spelling may be adopted. The improvement in machinery is so great and so rapid that the cost will not be excessive in all literature that interests the masses, and will probably decrease in a short time in those works that interest the scientific few. All the stores of the present time may still be studied by the patient searcher after truth with every advantage he now has. The general use of such universal alphabet would revolutionize the curricula of the common schools and of higher institutions as well. All of the time now wasted on the study of spelling could be devoted to some other branch that would be as effective for mental drill, and yet would be useful. Most of the time now devoted to reading—or, rather, its rudiments—in the elementary grades would be saved, to the gain of the pupil in actual knowledge. This would shorten the year of work in the common schools and enable pupils to enter high schools at an earlier age, or, perhaps, better still, would give the time needed for industrial training which is now not to be thought of. The high schools

and colleges would find the languages simplified, particularly in the elementary work.

It is not necessary now to determine when, where or by whom the universal alphabet shall be devised. It may be that a world's parliament can be held for consideration of this subject at some of the future international expositions. For the present it is sufficient to say that the linguist, the philologist, the oculist, the orthographer and other scientists should unite their learning to produce an alphabet which will be complete—which will correctly represent all the sounds of living tongues and dialects, and of the dead languages so far as can now be determined—which will be simple and pleasing in form, suitable for writing, printing and engraving—with capital and small letters alike, except in size, and with cursive, printed and engraved forms differing as little as possible, having due regard to their several needs and purposes; which shall minimize the strain on the eyes that comes from similarity of characters, hair lines, etc., and which shall blaze the way for an universal language that shall make feasible "the Parliament of Man, the federation of the world." The position of the vocal organs in producing the various sounds, from the full A(h) of Indo-European languages, to the Hottentot click, must be definitely determined and recorded. Then, with an universal system of punctuation and accent, any person who has once learned the alphabet will be able to read correctly any transliterated language, though he may not understand a word of it.

DIRECTIONS FOR MAKING "THE ROPE CYCLIST" LANTERN SLIDE.

By THEODORE BROWN.

Of the making of tricks and clever feats, certainly it can be said there is no end. When any new thing comes out that in any way lends itself as an accessory to some remarkable trick, it is certain to be eagerly and immediately seized upon by those whose self-appointed work it is to minister to the wants of those who are always ready to admire and applaud some feat requiring unusual skill and clever manipulation.

Thus, when the bicycle first came into general use as a means of locomotion, it was at once used for the performance of simple tricks; and as the bicycle has

FIG. 2.

been vastly improved in later years—almost beyond recognition, I might say—so has the number and nature of the clever tricks done by its aid been greatly altered also.

Now, it is quite a common trick among those high up in their particular profession to ride a single wheel in almost any position and at greatly varying rates on the stage, and there have not been wanting those who have combined tight-rope performances with these cycle tricks, and ridden their wheels across a suspended rope.

The particularly clever nature of the trick here described, and the simplicity with which it has been adapted and represented in a lantern slide, combine to make this a most effective slide. Without further introduction, I will proceed to the description of this slide.

It is sufficient to state that two glasses are employed, one being fixed and the other movable in a groove provided for it. Upon the same side of the sliding glass, 7 (Fig. 3), are glued two small blocks, 8 and 9,

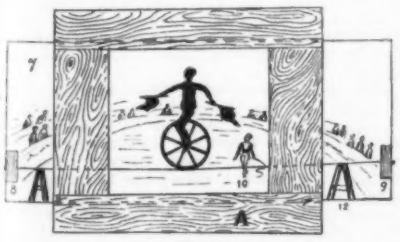


FIG. 3.

in the positions shown. (I might here mention that the sliding glass is not represented its full length in this drawing, for the purpose of economizing space. It may be made almost any length, of course.)

Through these two blocks passes a thread, which is wound in its course once round a grooved wheel, which we shall presently have need to refer to in greater detail. The string is secured by means of knots. Upon this glass also are painted figures, as shown, representing the spectators around the ring of the circus, where the performance is supposed to be taking place. These figures are made somewhat larger near the ends, for the purpose of obtaining the right perspective. 10 is the riding-master, always to be found in the ring when any performance is going on; 11 and 12 are the trestles, by means of which the rope is supposed to be suspended. In reality, of course, it is held by the blocks before mentioned.

We will now consider the fitting up of the fixed glass. This holds all the working parts, the wheel upon which the cyclist rides, and the cyclist himself. The component parts of the cyclist are cut out to the shapes shown in Fig. 2. All except the body, 2, are made of thin metal; 2 is made of thick wood. 1 represents the head and arms, which are in one piece. Flags are held in the hands for the purpose of balancing; 3 and 5 are the thighs and 4 and 6 the lower parts of the legs. 2 is, as we have just intimated, the body. 13 is a link connecting, as we shall see, the thigh, 5, with the head. The necessary holes must be bored in these parts in the places indicated in Fig. 2.

The body, 2, is then glued to the inner surface of

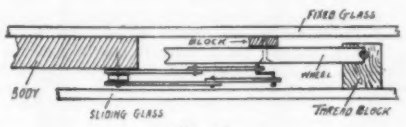


FIG. 4.

the fixed glass in its proper position, and the parts just described are pivoted and connected to it, as shown in Fig. 5. 1 is pivoted to the body, 3 and 5 are pivoted to the body at the same point, 4 and 6 are pivoted to the ends of 3 and 5 respectively, and the link, 13, is pivoted to 1 and 5, as shown.

Now, just below the body of the cyclist, a small block is glued to the fixed glass, as shown in the sectional diagram, Fig. 4. In this drawing, as will be seen, only the lower parts of the cyclist's body besides the wheel are shown. To this block is fastened a screw, represented by a dotted line, on which the grooved wheel before mentioned revolves. This wheel, which is, of course, that upon which the cyclist does his remarkable performance, bears a double crank, as shown in Fig. 4. This double crank passes through the holes made in the cyclist's feet.

Reference to Fig. 4 will show now the need for the greater thickness of the body. It is necessary in

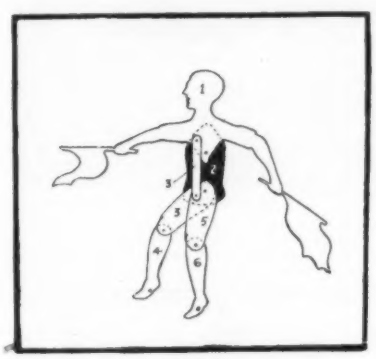


FIG. 5.

order that the legs—between which, it should be mentioned, there is a small washer to keep them the proper distance apart—may be on the same level as the double crank on the wheel.

When the slide has been fitted up in the manner described it is completed, and ready for exhibition in the optical lantern. Let us see what happens when the sliding glass is pushed in and out.

Reference being made to Fig. 3, it will be seen that if the sliding glass is pushed from left to right, the wheel will revolve in a forward direction, because the thread stretched between blocks 8 and 9 (Fig. 3) passes around the periphery. Now, as the wheel revolves, the double crank, with the cyclist's legs attached, revolves too.

It will be easily understood, then (by reference to Fig. 4), that the cyclist's legs will go through the ordinary pedaling movements, and owing to the special kind of crank employed, they will cross each other as they would in real cycling. At the same time, the leg, 5 and 6 (Fig. 5), moving up and down will, by the agency of the connecting link, cause the head and arms to sway backward and forward in the act of balancing.

The spectators passing by the cyclist in direction opposite to that in which he appears to be traveling, will make it appear that he is really progressing; and as the spectators will get smaller and smaller until he gets to the middle of the rope, and larger and larger as he gets to his journey's end, it will seem as though he were going through his performance on a rope suspended in the middle of a circus ring. When he arrives at the trestle the operator may, by pulling the sliding glass back again, make the cyclist retrace his steps, or rather, re-ride his wheel across the rope, and thus considerably add to the effect.—The Optical Magic Lantern Journal and Photographic Enlarger.

GROUNDNUTS AND GROUNDNUT OIL.

IT may be well to call the attention of importers and manufacturers to the statement of an American Consul relative to the importation and trade in groundnuts and the oil made from them.

According to him, the industry of the extraction of oil from seeds at Marseilles, which is more extensive than elsewhere in Europe, and is beginning to prosper, employs no special machine or process for the extraction of the oil from groundnuts different from that employed with other seeds, the extraction of this oil only occurring in favorable conditions of the market. The importation of groundnuts at Marseilles the last year amounted to 70,000 tons. The crude oil ought to be filtered in order to be of a bright yellow; if it is desired to be white, it should be treated, it is said, with clay. What is to be feared with this oil is that it is very difficult to detect its presence when used for the adulteration of olive oil, because the reaction is white. The uses of arachio oil are numerous. It is recognized as the most polymorphous oil in existence.

The Consul who writes this is ignorant of the fact that for a long time an extensive and flourishing trade in groundnuts has been carried on at Marseilles, and we can add to his information by saying that the arachidic oil, pressed cold, is used as an edible oil, and is thus employed as an adulterant for olive oils. When it is prepared hot or from seeds more or less fermented, it serves for the manufacture of soap and for lubrication.

The arachide is the fruit of the *Arachis hypogea*, and a native of Brazil, but it is cultivated on a large scale in Senegambia, especially in Senegal and Guinea.

For a long period there has been a large consumption of the roasted nuts in America under the name of the pea-nut, and in France under that of the *cacahouet*. —Translated from Les Corps Gras Industriels.

RECLAIMING THE ZUIDER ZEE.

RATHER more than fifty years ago arose the idea of adding by the arts of peace a twelfth province to the kingdom of the Netherlands, says The Engineer. In 1849 the engineer, Van Diggelen, published a project for cutting off the Zuider Zee from the waters of the North Sea, and then the inclosed space was to be pumped dry. The project was worked out most elaborately, but it was shown that its execution was a practical impossibility. Van Diggelen wished to reclaim not only the large southern expanse of the Zuider Zee, which forms a seaboard for the very heart of Holland, but he was so ambitious as to entertain the project of reclaiming from the sea the region lying between the province of Friesland and the outlying fringe of the four islands of Texel, Vlieland, Terschelling, and Ameland. The eastern end of the enormous work would have been at the Lauwer Zee, at the very center of northern Holland. However, the idea was held to be impossible of accomplishment from a technical point of view, and the economic results were regarded as not likely to be sufficiently remunerative to pay the immense outlay necessary. A second and more modest project was brought forward in 1866 by Engineer Beyerinck; and in 1877 the Dutch Government commissioned M. van Stieltjes to draw up the necessary plans for draining the Zuider Zee, but owing to a change in the government the project was allowed to lapse. At last, in January, 1886, the "Zuiderzeevereeniging" was established, with the idea of reclaiming the Zuider Zee. The association was well supported by the leading authorities in the five provinces which encircle the Zuider Zee, and it was joined by fifty-two parishes, sixty-four water guilds, and by many agricultural, trading, industrial and shipping societies, and also by great numbers of private individuals. The association then set to work, and for some years the general public could see but small results. The main part of this preparatory activity consisted at first in examining the nature of the soil underlying the waters of the Zuider Zee, and then in working out the practicability of the various details involved in carrying out the project. The leading engineer in charge of the project was M. Lely, who, curiously enough, happens to be Minister of Waterworks at this moment, and it has been reserved for him to lay before the Second Chamber a bill for "Cutting off and Draining the Zuider Zee." According to the plan drawn up by M. Lely, the work of draining the Zuider Zee will be undertaken mainly by the Zuiderzeevereeniging, under the supervision of the State, and the State will be responsible for the necessary money.

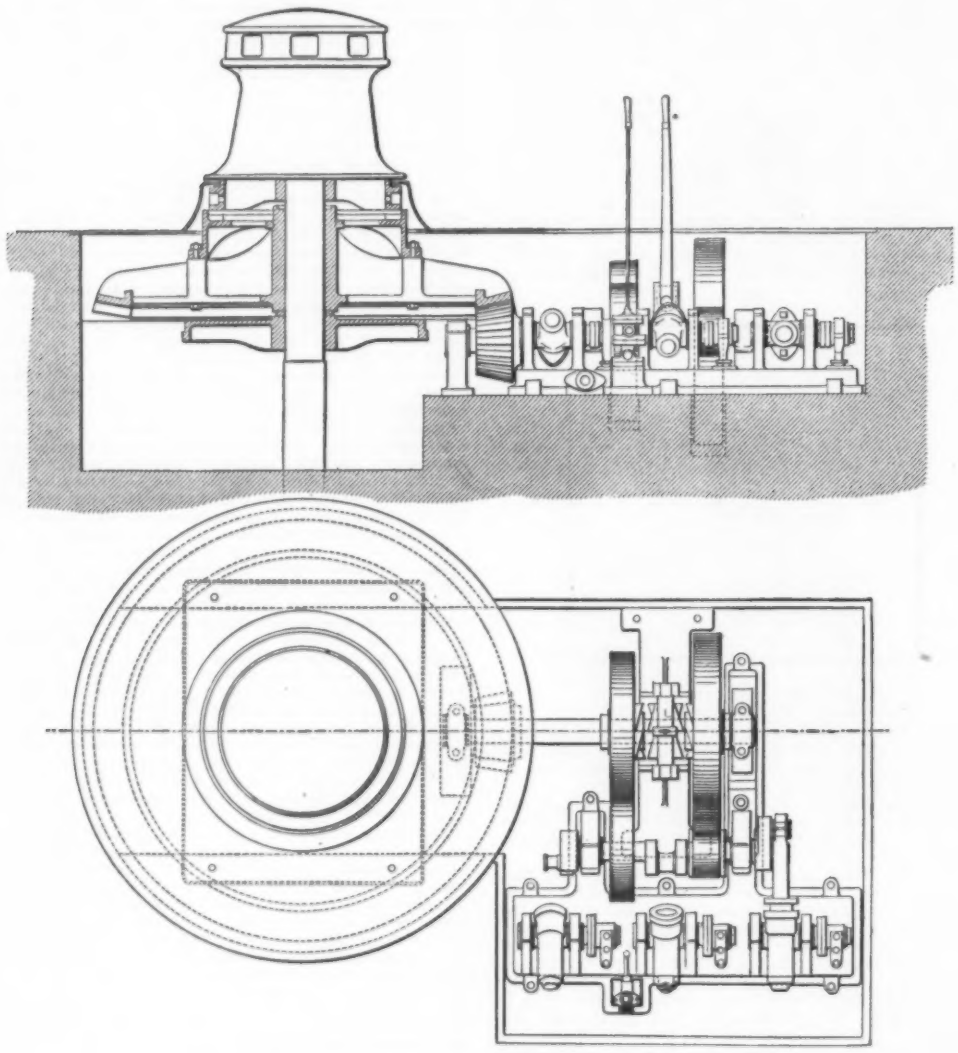
The great work is to be carried out as follows: At first a dyke will be built from the northeastern point of the province of North Holland, and through the narrow Amstel Deeps to the island of Wieringen. Thence the dyke will be constructed in a northeasterly direction to a point on the mainland near the village of Piaam, in the province of Friesland. Piaam is situated between the small towns of Makkum and Workum. When this dyke is built, the Zuider Zee will be cut off from the North Sea, and it will then be converted into an inland lake. So far as the actual reclamation of the Zuider Zee is concerned, two portions are for the present marked off for being dealt with. The first is that portion of it known as "De Meer," and it is contained by the coastline of the province of North Holland, the dyke, the island of Wieringen, and, finally, by a circular dyke, to be built from Wieringen in a huge curve toward the east and the south until the coastline of North Holland is reached again in the neighborhood of Medemblik. This portion is known as the "Northwest District." The second region, the southwestern, is bordered by the coastline of North Holland and by a circular dyke to be constructed from Blookershoek down to the northern shore of the Monnickendam Gat. The dyke to be built northward of Wieringen to the opposite coast of the province of Friesland will be 40 kilometers in length, and, as at present the coastline of the Zuider Zee has to be protected against the North Sea for a distance of 320 kilometers, there will be an immense saving in thus reducing these 320 kilometers to 40 kilometers. Near Kampen, the central point of the eastern coast line of the Zuider Zee, and four miles from its mouth, the silted up Yssel enters the Zuider Zee, and will bring a good supply into the projected fresh water lake. The province of Friesland has felt for many years the want of drinking water, which has often had to be obtained from England. Thus, Lake Yssel will take the place of the historic Zuider Zee, and it will receive the rainfall of five provinces around the coast line. Moreover, the construction of the dyke will put an end to the damage done to the coast line by the storms which at present rage upon the Zuider Zee. Finally, the summit of the dyke will be wide enough to admit of a line of rails being laid upon it; thereby North Holland will be brought into direct communication with Friesland, and the land journey from Amster-

dam to Leeuwarden will be shortened by 50 kilometers.

With regard to the financial aspect of the project, it is estimated that the cost of constructing the dyke will amount to 40,800,000 gulden, and to this must be added 17,000,000 gulden for waterworks, the construction of fortresses, and especially for compensating the fishermen of the Zuider Zee. Then the sum of 35,550,000 gulden is estimated to represent the cost of laying out as "polders" the 46,520 hectares of fruitful reclaimed land. These new polders will form an addition of about 140,000 English acres. Thus, in round numbers the total outlay will amount to 95,000,000 gulden, or £7,916,666, and the whole project is to be completed in eighteen years. The necessary funds are to be raised by means of a loan, which is to be redeemed during the next sixty years, although it is expressly stated in the scheme of the project that recourse may have to be had to the ordinary revenues of the State, seeing that "nations have before now had to make greater and more keenly felt sacrifices for the purpose of enlarging the area of their country."

HYDRAULIC CAPSTAN FOR THE MERSEY DOCKS.

WE illustrate herewith a hydraulic capstan recently constructed by C. and A. Musker, Limited, of Liverpool, for the Mersey Docks and Harbor Board. Our drawing shows a double power capstan, of which a large number have been supplied. It has a hauling power of 11 or 4 tons under water pressure, but can



MERSEY DOCK—DOUBLE-POWER HYDRAULIC CAPSTAN.

also be worked by hand. It is operated by a set of three-throw horizontal water engines, the cylinders oscillating in trunnion bearings. The valves are of the trunnion type, of hard phosphor bronze working in leather packings to minimize friction. The rams drive a crank shaft connected with the capstan barrel by spur and bevel gearing. The capstan barrel is driven by strong steel pawls working in a ring connected to the large bevel wheel, and rotates on a strong steel spindle. It is carried from the top by a cap connected by bolts to the barrel. A split collar and hard phosphor bronze seating are provided. The clutch gear is situated between the spur gearing, and permits of instantaneous change from single to double power. A starting valve of the slide valve type, with combined stop valve, is placed in close proximity to the capstan, so that all motions are directly under the control of the operator.—For our engraving and the foregoing particulars we are indebted to The Engineer.

TIDE MILLS.

THE curious system of utilizing the power of the tides through the medium of water-wheels seems to have been carried at one time to a considerable degree of perfection, and its total desuetude is a remarkable proof of how a new and successful invention may completely replace one having many and obvious advantages, but which had not been carried to the highest development of which, probably, it was capable.

Tide mills have been, of course, completely superseded by steam, and windmills nearly so, but both were known on the Continent some time before they were introduced into this country. A master carpenter of Dunkirk named Perse is credited in old authors who lived pretty near his time with having invented the former in the seventeenth century. So late, however, as the middle of the eighteenth, tide mills were hardly known here, and in 1760 the Society for the Encouragement of Arts, Manufactures, and Commerce offered a premium of £60 for the best model of one. The general principle was that of placing a wheel with broad floats across the inlet of a large pond or reservoir excavated close to a tidal river. While the tide was rising and flowing into the reservoir it turned the wheel one way; when running out, on the ebb tide, the wheel, of course, reversed its motion. Several methods were adopted for overcoming this difficulty, where it was found to be such. The wheel was placed at a constricted part of the water inlet, having flood gates at a little distance on each side. Side cuts ran round, one on each side, the right-hand one starting and finishing above these gates, the left-hand branch below them. Each branch had a gate at the center of its length, about in a line with the axis of the wheel. When the tide was rising, the gates in the through central passage being open and the side ones closed, water passing to the inner pond turned the wheel for about four and a half hours of the six the tide rises. When ebb commenced, the locks in the side passages were opened and those in the main channel closed. By this means the water going out along the left-hand cut was stopped from going straight into the river, but compelled to pass under the wheel to near the inner lock, which being also closed, it could only get away by the right-hand passage. A similar stoppage, of course, took place at low water, but the mill could be run with great certainty for eighteen hours out of the twenty-four. By an arrangement of a double pond with self-acting gates, which admitted the tide to the height of 7 or 8 feet, and closed on its turning, continuous motion could practically be had, the second reservoir being dug to a greater depth than the other. The gates of this opened outward to the sea or river, so that it could not get in, but on being opened at ebb tide the reservoir cleared itself. The wheel had to be placed at about the level of the bed of the shallower basin, and with proper proportioning there was hardly any idle time. Plans of mills on both these systems may be found in the Universal Magazine for September, 1760.

A tide mill or "flood mill" existed at Deptford until comparatively recent times in the River Ravensbourne, about 200 yards below the bridge on the way from London to Greenwich. It was there in 1802, and in 1825 was termed the "old flood mill." It then belonged to Christ's Hospital, and the incoming tenant was expected to rebuild it. Possibly it had become dilapidated, as the site and head of water were to be let on a building lease. The mill, as rebuilt, consists of an old wood and brick structure close to the junction of Reginald Road, Church and Creek Streets, Deptford, and is in the occupation of J. & H. Robinson, millers. It is still known as Tide Mill. The wheel-race remains, connecting the main stream with an artificial branch of the river. In this case the Ravensbourne itself must have served to keep the mill going while the tide was running out.

The largest and most complete tide mill we have any account of was erected on the bank of the Thames, in East Greenwich marshes, about midway between the spot now occupied by the Blackwall Tunnel and Woolwich. It was designed by John Lloyd, an engineer, of Westminster, and was intended to obviate the disadvantage caused by the gradual diminution of power as the river and reservoir got nearly full or empty. The mills were intended to grind corn for the London Company for the Manufacture of Flour. The mill-house was parallel to the bank of the river, and had a 40-foot waterway, within which was a wheel 26 feet long, 11 feet in diameter, and carrying thirty-two floats on its circumference. To lessen the shock of the water, these floats were not continuous, but divided into four sections breaking joint with each other. The wheel, with the whole of its apparatus, weighed about 30 tons. The side spaces of 6 feet or 7 feet were to allow the water to get freely into or out of the reservoir, but apparently could have been occupied by a larger wheel, or additional small ones. The wheel revolved in a stout wooden framework, which rose and fell with the tide by the action of what were virtually bellows. Planking, hinged to the floor of the frame and to the base of the beams or posts which served as guides to the framework, projected backward toward the inner pond. The tide could not get through this—whereby it would have diminished the power available for the wheel—but gradually forced it up as it rose, thus keeping the wheel at a suitable level. The reverse action, of course, took place when the reservoir was emptying, maintaining the wheel again at a good working level. On each end of the drum or water wheel was a ring of cogs, engaging by bevel gear with the base of upright shafts rising into the mill to turn the machinery. There were two bevel wheels on each shaft, a lever being provided for changing from one to the other when the motion of the wheel was reversed after the necessary stoppage at the change of tide. A system of counterweighted gates was employed to regulate the flow of water to the wheels. A patent, No. 2411, for tide mills constructed in this manner was granted on June 10, 1800, to William Johnson, of Bromley, Kent, gentleman. In a long advertisement, published six months later, he anticipates the construction of the East Greenwich mills, and describes the merits of his plan in a glowing style not unusual with inventors. It required a smaller reservoir than usual, as the water ran over the top of the gates down upon the wheel, and acted by its weight, instead of by impulse, as on the undershot method. He estimated that where the tide rose 15 feet a basin 125 yards square and 21 feet deep would hold enough water to grind and dress 468 bushels of wheat every twenty-four hours, or every twenty working hours, four being allowed for stopping to let the tide get a good start. A large part of the pond attached to these mills is still traceable, though a good deal has been filled up with cinders, and the works of the Blackheath and Greenwich District Electric Lighting Company occupy nearly the site of the old tide mill. As a bank 8 feet or 10 feet high surrounds the pond, it was evidently able to hold water up to the top level of the tide. Though now choked with mud, the bottom of the pond must have been lower at one time. This rapid filling with mud was one of the drawbacks of the system.

One of the earliest of Richard Trevithick's high-pressure engines was employed pumping at East Greenwich tide mills while the basin was excavating. It had a cast iron boiler 6 feet in diameter and from 1 inch to 1½ inch thick in different places, according to Trevithick himself. This boiler blew up in September, 1803, killing three men and injuring others. The boy in charge had gone off to catch eels in the basement of the mill, and a laborer had stopped the engine because it was going too fast. This is a characteristic specimen of the happy-go-lucky enginemanship of those days. A boiler of the same kind may be found at South Kensington Museum.

A tide mill existed at least so early as 1786 in Nine Elms Lane, Battersea. Its site is now a little creek running in from the Thames to the premises of the Gas Light and Coke Company, about half a mile from Wandsworth Road. The bridge over it is still termed Millpond Bridge. Originally the pond was small and contained an island, but later on was enlarged and extended southward. It is now covered by the running sheds of the London and Southwestern Railway. When first opened in 1838, the line crossed this pond on a viaduct, but it had already acquired the reservoir, and soon after filled it in. The neighborhood then consisted chiefly of nursery gardens, and was rather pretty. Some twenty-five years ago it was said that "the only vestige of the mill remaining is the outward carcass, which is in a ruinous condition." Even this has now disappeared.

Probably much the oldest of these Thames tide mills was Savory Mill, on the east side of Savory Dock, now St. Saviour's Dock, a creek in Southwark about a quarter of a mile below the Tower Bridge. It was not connected with the creek, however, but with a stream, now non-existent, called the Neckenger. This, of course, was tidal, besides a series of ditches running out of it, which afforded a supply of water to the tanners. The ditches have long been filled up, but they must have answered instead of a pond very well, to keep the mill going. Mill Stairs still commemorates the machine, which is shown in a map of 1742 as Savory Mill Stairs.

About a mile farther down was the King's Mill. In July, 1779, a large reservoir, built as an additional source of supply to this mill, burst and flooded a great extent of the low-lying garden grounds. The King's Mill was a little below the Thames Tunnel, on the Surrey side.

The name Sea Mills, between Bristol and Avonmouth, seems to indicate tide mills, for which the great range of the tides in the Avon would be well suited. Foundations of buildings, possibly a mill, may be seen alongside the river close to the station, while the little river Trim, coming in there, might serve instead of a pond.

A very fine tide mill, the buildings of which remain intact and were in use till within the last few years, was situated at Bishopstone, Sussex, between Newhaven and Seaford. It was built by the Duke of Newcastle in 1761 and was worked directly by a side-cut from the Ouse at Newhaven, the waste water escaping into lagoons near the shore. Originally they contained four pairs of stones, but later on sixteen. The newer portion, to admit of this, is very noticeable. Under it, on the Newhaven side, are two large arches, the wheel being visible inside. Five smaller arches must have led to other wheels under the old portion. All the arches have gratings right up to the top. The water flowed under the mill and roadway and out by a small aperture into a pond, but the exit of the latter is now obliterated by shingle banks and the new sea wall. The entrance from the river to the cut seems also to be closed. The windows of the old part of the mill are now bricked up and the whole is used as a warehouse. There is a short siding from the adjacent Bishopstone station. These mills were at one time worked by Catt & Son, whose descendants are still millers at Brighton.—The Engineer.

NEW FORM OF CHARTER GAS ENGINE.

The use of gasoline engines for all kinds of purposes has reached a point that the most optimistic enthusiast would not have thought of phophesying fifteen years ago, when the first engine to successfully use gasoline in internal combustion engines was placed on the market. This engine is still being manufactured on the same general principles that gave it such a good record for reliability, safety, and staying qualities. The design has been changed somewhat, so as to make a more symmetrical machine, and one thoroughly abreast of the demands for first-class machinery, which all machinery manufacturers realize they must meet if they desire to maintain their reputation in the 20th century.

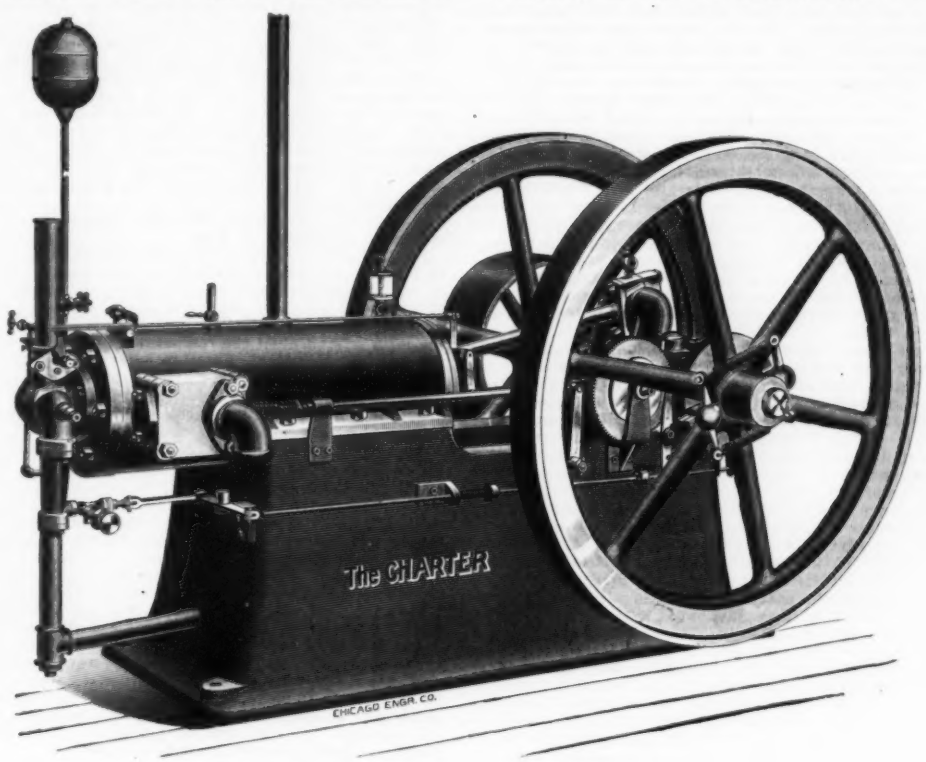
By reference to the illustrations, one of which shows the general appearance and the other an outline of all the working parts of the engine, the extreme simplicity and fewness of parts attract attention. A large number of people are familiar with the operation of a gasoline engine, but there is a still larger number who are not, and for the benefit of the latter we publish this article.

Internal combustion engines do not require a boiler to produce the gas for operating the engine, but simply use hydrocarbon in the form of gasoline, distillate, or coal oil, and mix it with the required volume of air, compress the air and gas into the back part of the cylinder, and at the right moment ignite the mixture under compression, either by electric spark or hot tube. The operation is as follows:

The needle valve, *A*, which admits gasoline to the injector, *G*, is opened a very little so that as the piston is drawn forward the cam on large gear will open the injector, when a spray of gasoline mixes with the air that is being drawn into the cylinder through the air pipe, *N*. The gasoline is diffused through the air so that there is a cylinder full of gasoline and air in proper proportions to burn in a closed vessel. The piston is then pushed back by the turning of the crank, so that the cylinder full of air and gasoline is compressed to a small part of its original volume, and while under compression, the charge is ignited by means of a heated tube closed at the top end (the opening at bottom end connecting with the inside of cylinder), or an electric spark obtained from a primary battery or a small dynamo, arranged by suitable mechanism to ignite the charge at the correct position of the crank to give the best results for power and efficiency. The ignition of the gaseous mixture produces a pressure of about 180 pounds per square inch, which, acting on the piston, pushes it forward and is turned into useful work by the rotation of the crankshaft. When the pressure due to the ignition of the gas has spent itself by pushing the piston to its extreme forward position, a cam located on the back side of large gear comes in contact with the rod which opens the exhaust valve, *D*. This valve, *D*, opens the port connecting the inside of cylinder with the air outside, and being held open during the back or in stroke of the piston, the spent gas is expelled into the muffler or exhaust pot, and from that to the outer air.

The cycle of operation continues as long as it is desired to run the engine. The gasoline is pumped from a tank buried in the ground by the small pump shown at the side of the engine, and is forced up into the standpipe, keeping it full, all excess gasoline returning to the tank. The engine takes only enough gasoline to maintain its motion according to the work done, the admission of gasoline being controlled by the governor acting upon the horizontal rod which is connected to injector, *G*.

This engine is manufactured by the Charter Gas Engine Company, of Sterling, Ill., and although the pioneer gasoline engine of the world, has never had an instance of fire or explosion caused by the engine, a record which is not duplicated.



NEW FORM OF CHARTER GAS ENGINE.

VITRIFIED QUARTZ.

At the Royal Institution in March last W. A. Shenstone gave a practical demonstration of making chemical apparatus with vitrified silica, showing that he has been successful in overcoming many of the difficulties encountered in working this material in the oxyhydrogen blowpipe flame. The splintering property of quartz when suddenly introduced into a hot flame was overcome by heating it in small fragments to about 1,000 deg. C., then plunging it into cold water. It then becomes white and enamel-like; when the process is repeated, the quartz no longer splinters when heated, even when at once thrust into the blowpipe flame, and again becomes transparent. By softening these annealed pieces in the hottest portion of a "mixed gas'" jet, and pressing the heated ends of the fragments together, while held in a platinum forceps, a rough rod is built up. This is then slowly reheated from below upward, and drawn out into small rods of about 1 millimeter diameter. A few of these rods are then bound round a stout platinum wire and heated until their sides coalesce. The rough tube thus produced is reheated, drawn out, and sealed at one end. A bulb is then blown in the usual manner, which, when drawn out, forms a fairly regular tube. This may be lengthened by adding pieces of softened silica to one end, again blowing and drawing out. Small bulbs may be enlarged by applying rings of particles of softened silica to the outer side, heating until these begin to spread, and then blowing. In this way bursting of the bulb is avoided, and a wall of fairly uniform thickness is obtained. It is necessary to protect the eyes during this work with spectacles, the glass of which is so dark that white-hot silica does not appear very bright when viewed through it. Vitreous silica has a remarkable property of withstanding sudden extreme variation in temperature. Tubes composed of it may be plunged suddenly into the oxyhydrogen flame without injury; white-hot silica may be plunged into cold water, or even into liquid air without harm; in fact, it seems to gain in elasticity by such treatment. Apparatus of vitrified silica will probably be of great service to physicists in the construction of thermometers, in tubes for electro-spectroscopic work, and in many other directions. The apparatus must not, however, be employed with hot alkali, or in contact with basic oxides at high temperatures. It becomes slightly permeable to hydrogen at about 1,000 deg. C., but to a less degree than platinum.—Chem. News, 83, 205.

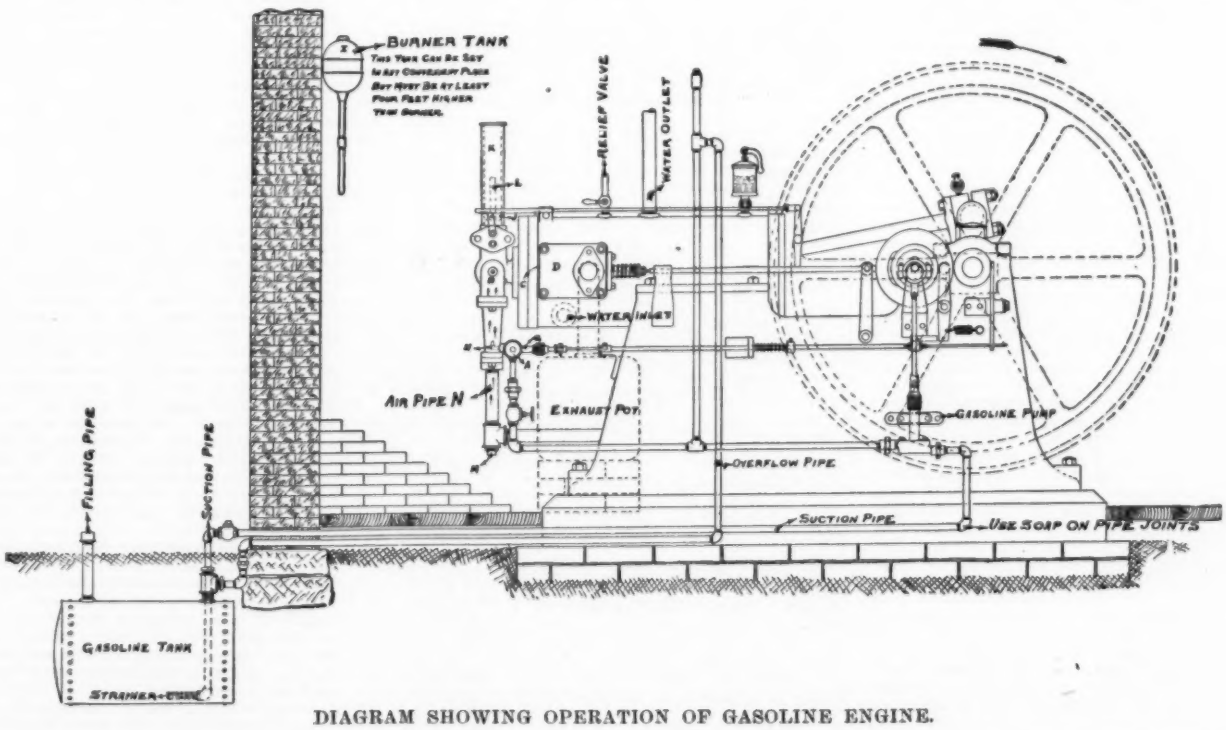


DIAGRAM SHOWING OPERATION OF GASOLINE ENGINE.

HOUSEHOLD TESTS FOR THE DETECTION OF OLEOMARGARINE AND RENOVATED BUTTER.

By G. E. PATRICK, Assistant Division of Chemistry, Department of Agriculture.

*Renovated or Process Butter.**—Oleomargarine is no longer a novelty to Americans; its composition and method of manufacture have become matters of common knowledge. Renovated or "process" butter, on the other hand, having been introduced in a large way hardly more than five or six years, and being retailed usually without other designation than the general one of "butter," is as yet hardly known to the general public. All grades of it—good, indifferent, and bad—are met with in our markets. The better grades of it are made from miscellaneous assortments of "country butter," mainly "farmers' rolls," produced by individual farmers remote from creameries and sold or exchanged at the country stores, this material being treated or "processed," as the term is, while still fresh or relatively so. The poorer grades result from the treatment of inferior raw material; for example, the aforesaid "country butter," or any other kind of butter, which, by too long keeping, by abuse in regard to temperature, or by unfavorable surroundings, has suffered great deterioration. Experience has shown that only a poor article of renovated butter can be produced from rancid "stock."

How Renovated or "Process" Butter is Made.—The process may be briefly outlined as follows: Melting of the butter and settling of the curd and brine, skimming off of broth and scum, drawing off and discarding of the curd and brine, blowing of air through the molten fat to remove faulty odors, mixing of milk very thoroughly with the molten fat, rapid cooling and "granulating" of this mixture by running it into ice-cold water, draining and ripening of the granulated mass for a number of hours, salting and working out of the excess of milk, packing or making into prints.

By this process, when used upon comparatively fresh raw material, butters of low grades are materially improved, the farmer's revenue is increased, values are enhanced—in short, a good thing is done. Harm begins only when the renovated is sold for the genuine (that is, the original) article, for they are not the same thing. While the fats in the two are practically the same chemically, the nitrogenous portions are not. Moreover, since the article known now and for ages past as "butter" is an article the last step in whose manufacture is the churning of cream, it is evident that the product of an elaborate subsequent process, a process entirely foreign to the manufacture of "butter," should be designated by a distinctive name.

How to Distinguish Genuine Butter from Renovated, and Both from Oleomargarine.—Several of the States have already enacted laws requiring the distinctive branding or labeling of the new product when offered for sale, and as a consequence chemists have, during the last year or two, devoted considerable study to methods for distinguishing between the genuine and the renovated article. One of the results of such study is the method of Hess and Doolittle (published in 1900) which is based upon the difference in the relative proportions of albumen and so-called "casein," as well as the different properties of the latter, existing in the two products. But as this is distinctly a laboratory method, quite inapplicable in the household, it will not be dwelt upon here.

Another useful method, of the nature of a preliminary test, is that of microscopic examination by polarized light, with and without the selenite plate; but for the reason just stated, this, too, will be passed with a bare mention. So also with various chemical tests and the regular chemical analysis of the fats.

HOUSEHOLD TESTS.

The Boiling Test.—Another important means employed in distinguishing between genuine and renovated butter is the boiling test. This test was first mentioned in scientific literature by Dr. Henry Leffmann, who states (Report of State Board of Agriculture of Pennsylvania for 1892, p. 121) that it was shown to him by a Mr. Morris, a detective in oleomargarine prosecutions. It has been in use about ten years, and was originally used only for the detection of oleomargarine; but after the advent of renovated butter the test was found to serve almost equally well in distinguishing this product from genuine butter. Therefore, this test distinguishes between genuine butter on the one hand and oleomargarine and renovated butter on the other; and, fortunately, it is so simple of execution that it can be employed in any kitchen almost as well as in the laboratory, and requires no special skill on the part of the operator. It consists merely in boiling briskly a small portion of the sample and observing its behavior the while.

In the kitchen the test may be conducted as follows: Using as the source of heat an ordinary kerosene lamp, turned low and with chimney off, melt the sample to be tested (a piece the size of a small chestnut) in an ordinary tablespoon, hastening the process by stirring with a splinter of wood (for example, a match). Then, increasing the heat, bring to as brisk a boil as possible, and after the boiling has begun, stir the contents of the spoon *thoroughly*, not neglecting the outer edges, two or three times at intervals during the boiling—always shortly before the boiling ceases. In the laboratory a test tube, a spoon, or sometimes a small tin dish, is used in making this test. From the last-named utensils the test is often called the "spoon test," and sometimes the "pan test."

A gas flame, if available, can be used more conveniently, perhaps, than a kerosene lamp.

Oleomargarine and renovated butter boil noisily, sputtering (more or less) like a mixture of grease and water when boiled, and produce no foam, or but very little. Renovated butter produces usually a very small amount.

Genuine butter boils usually with less noise, and *produces an abundance of foam.*

The difference in regard to foam is very marked, as a rule. Rarely, a butter is found which yields an uncertain result; such a butter should receive the benefit of the doubt.

A very few samples of "ladled" butter have been observed in this laboratory to yield a rather scanty foam. "Ladled" butter is the product obtained by working together, and washing at the same time, several different lots of "country butter," coloring the whole to a uniform shade. The best grade is sometimes sold for table use, lower grades go for cooking; but it is becoming less and less abundant in the market, especially the lower grades, since it is being largely replaced by renovated or "process" butter.

The Waterhouse Test.—This test for the detection of oleomargarine was devised by Mr. C. H. Waterhouse, dairy instructor at the New Hampshire College of Agriculture and Mechanic Arts, not long before his death, in the summer of 1900. Previous to his sickness he described the test to Prof. C. L. Parsons, of the same college, requesting him to submit it to trial. This Prof. Parsons has done, finding it entirely reliable so far as his trials extended, and the result, together with a description of the test, was published in the March number of the Journal of the American Chemical Society (p. 200).

Following is Professor Parsons's description of the test, with comments by him:

Half fill a 100 cc. beaker with sweet milk, heat nearly to boiling, and add from 5 to 10 grammes of butter or oleomargarine. Stir with a small rod, preferably of wood and about the size of a match, until the fat is melted. The beaker is then placed in cold water and the milk stirred until the temperature falls sufficiently for the fat to congeal. At this point the fat, if oleomargarine, can easily be collected together into one lump by means of the rod, while, if butter, it will granulate and cannot be so collected. The distinction is very marked.

The stirring is not, of necessity, continuous during the cooling, but it should be stirred as the fat is solidifying and for a short time before.

The milk should be well mixed before being turned into the beaker, as otherwise cream may be turned from the top and contain so much butter fat that the test is vitiated for oleomargarine.

In conclusion, Professor Parsons says:

"While the small number of samples (21) of oleo to which the test has been applied will not allow of a positive statement of its universal application, I am convinced from my own experience that it will prove of value, especially in the hands of revenue agents and others employed in detecting illegal sales of oleomargarine, as it may materially lessen the number of samples to be sent forward for the final proof of chemical analysis. If this test is found to be of use, it should be known as the Waterhouse test."

Department Experiments with the Waterhouse Test.—This remarkable and simple test, in a slightly modified form adapted to household conditions, has been quite carefully studied in the chemical laboratory of the Department of Agriculture, with the result of finding that while oleomargarine gathers in the manner stated by Prof. Parsons (except when cooled very rapidly indeed, as by a large quantity of ice water, when it granulates instead of gathering), renovated butter also gathers, but is prevented from so doing and made to granulate by a less rapid cooling, as by using a smaller quantity of ice water; and, finally, that some samples of genuine butter, or presumably genuine butter, purchased as such in the open market, will gather when cooled very slowly by means of water only moderately cold and when partially skimmed milk is used in the test.

These facts make it evident that in using the Waterhouse test extreme care is essential in regard to rapidity of cooling if oleomargarine is to be distinguished from renovated butter. We have, however, found it quite possible to make this distinction with a high degree of certainty by controlling the rapidity of cooling by means of ice and a limited amount of ice water, as well as by a uniform method in regard to the stirring.

The Waterhouse Test, at Ice Water Temperature, Adapted to Household Conditions.—The household adaptation of the test which we here present has given us excellent satisfaction in a large number of trials with oleomargarines and both renovated and genuine butters.

Since the results of the test are easily changed by rather small variation of the conditions, or the details of manipulation, it is important to follow the directions carefully in every detail. If this is not done, erroneous results may be obtained.

TO DISTINGUISH OLEOMARGARINE FROM RENOVATED AND GENUINE BUTTER.

Utensils Required.—The utensils required in the test to distinguish oleomargarine from renovated and genuine butters are as follows:

(1) A one-half pint tin "measuring cup," common in kitchen use, marked at the half and quarters; or a plain one-half pint tin measure, ordinary narrow form; or an ordinary small tin cup, 2¾ inches in diameter and 2 inches in height, holding about one gill and a half.

(2) A common kitchen pan, about 9½ inches in diameter at the base.

(3) A small rod of wood, of the thickness of a match and of convenient length for stirring.

(4) A clock or watch.

The Process.—The process for distinguishing oleomargarine from renovated and genuine butters is as follows:

Use sweet skimmed milk, obtained by setting fresh milk in a cool place for twelve to twenty-four hours and removing cream as fully as possible. Half fill with this milk the half-pint cup or measure, or two-thirds fill the smaller cup mentioned, measuring accurately the gill of milk when possible; heat nearly to boiling, add a slightly rounded teaspoonful of the butter or butter substitute, stir with the wooden rod, and continue heating until the milk "boils up,"* remove at once from the heat and place in the pan (arranged while milk and fat are heating) containing pieces of ice with a very little ice water, the ice to be mostly in pieces of the size of one to two hen's eggs (not smaller, as small fragments melt too rapidly) and sufficient in quantity to cover two-thirds of the bottom of the pan; the water to be in quantity sufficient, when the cup is first placed in the pan, to reach on the outside of the cup to only one-fourth the height of the milk within; any water in excess of that amount must be removed. (This refers to the condition at the beginning of the cooling; later, as the ice melts, the water will rise to a higher level.) Stir the contents of the cup rather rapidly, with a rotary and a crosswise motion in turn, continuously throughout the test, except during the moment of time required for each stirring of the ice and water in the pan, which must be done thoroughly once every minute by the clock. This is done by moving the cup about, in a circle, following the edge of the pan. Proceed in this manner for ten minutes, unless before that time the fat has gathered or has allowed itself to be easily gathered, in a lump or a soft mass, soon hardening. If it so gathers, the sample is oleomargarine; if not, it is either genuine or renovated butter.

Thus far in our experience the results obtained by the test operated in this manner, carefully and with due regard to details, have been always correct and free from uncertainty, with only two exceptions. These exceptions were two very stale and rancid samples of oleomargarine that had been in the laboratory several months and had become entirely unfit for culinary use; in fact, one had become oily and moldy. Fortunately, such samples do not require testing in the household, and a rancid oleomargarine is easily distinguished from a rancid butter by the sense of smell alone.

In several other samples of stale and rancid oleomargarine we have observed the tendency exhibited by the two just mentioned, namely, a tendency to be kept from gathering—that is, to become granulated—by a temperature slightly less cold than is required to prevent fresh oleomargarine from gathering. But of the eight such samples we have tested, only the two mentioned were sufficiently erratic in their behavior to escape detection by the test.

The boiling test ("spoon test"), given above, enables one to distinguish in the great majority of cases between genuine butter on the one hand and oleomargarine and renovated butter on the other; the Waterhouse test, household adaptation as just given, enables one to distinguish between the two last named; and so, by the use of the two tests, one can determine in nearly every instance which of the three he has in hand. There are many persons who are able to recognize oleomargarine, almost without fail, by taste and smell alone. To those possessed of this power the boiling test, which is performed with almost no trouble, will serve every needful purpose.

MARKETING AND PRESERVING EGGS.*

IN earlier times eggs, if sold at all, were marketed near the place where they were produced. Many are still sold in local markets; but with improved methods of transportation the market has been extended and large quantities of eggs are shipped from this country and Canada not only to distant points in America, but to England and more distant countries. For shipping long distances there are special egg cases, and the shipper should select the kind which is preferred in the market which he desires to reach.

The shells of new-laid eggs should be wiped clean, if necessary, and the eggs graded as regards size. In some markets brown eggs are preferred to white. It is stated that in the Boston market brown-shelled eggs, such as are laid by Partridge Cochins, Dark Brahmas, Barred Plymouth Rocks, etc., sell at from 2 to 5 cents per dozen more than white-shelled eggs, such as are laid by Brown Leghorns, Buff Leghorns, and White and Black Minorcas. In the New York market, on the other hand, white-shelled eggs bring the higher price. The color of the shell has no relation to the food value, as is shown by analysis.

Eggs which are to be shipped, whether with or without a special attempt at preservation, should be perfectly fresh, and should never be packed in any material which has a disagreeable odor. Musty straw or bran will injure the flavor and keeping qualities of eggs packed in it. When shipped, eggs should not be placed near anything which has a disagreeable or strong odor. Keeping eggs near a cargo of apples during transportation has been known to injure their flavor and also their market value. As previously noted, micro-organisms may enter the egg through the minute pores in the shell and set up fermentation which ruins the egg. In other words, it becomes rotten. The normal eggshell has a natural surface coating of mucilaginous matter, which hinders the entrance of these harmful organisms for a considerable time. If this coating is removed or softened by washing or otherwise, the keeping quality of the egg is much diminished. If the process of hatching has begun, the flavor of the egg is also injured.

There are many ways of testing the freshness of eggs which are more or less satisfactory. "Candling," as it is called, is one of the methods most commonly followed. The eggs are held up in a suitable device against a light. The fresh egg appears unclouded and almost translucent; if incubation has begun, a dark spot is visible which increases in size according to the length of time incubation has continued. A rotten egg appears dark colored. Egg dealers become very expert in judging eggs by testing them by this and other methods.

The age of eggs may be approximately judged by taking advantage of the fact that as they grow old their density decreases through evaporation of moisture. According to Siebel a new-laid egg placed in a vessel of brine made in the proportion of 2 ounces of salt to 1 pint of water, will at once sink to the bottom. An egg 1 day old will sink below the surface, but not to the bottom, while one 3 days old will swim just immersed in the liquid. If more than 3 days old, the egg will float on the surface, the amount of shell exposed increasing with age; and if two weeks old, only a little of the shell will dip in the liquid.

The New York State Experiment Station studied the changes in the specific gravity of the eggs on keeping and found that on an average fresh eggs had a specific gravity of 1.090; after they were 10 days old, of 1.072; after 20 days, of 1.053, and after 30 days, of 1.035.

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* Also known locally in New England as "sterilized" butter.

* This slight departure from the original Waterhouse test is in order to secure always the same temperature of the milk.

* Section of Farmer's Bulletin No. 128, U. S. Department of Agriculture. By C. F. Langworthy, Ph.D.

The test was not continued further. The changes in specific gravity correspond to the changes in water content. When eggs are kept they continually lose water by evaporation through the pores in the shell. After 10 days the average loss was found to be 1.60 per cent of the total water present in the egg when perfectly fresh; after 20 days, 3.16 per cent, and after 30 days, 5 per cent. The average temperature of the room where the eggs were kept was 63.8 deg. F. The evaporation was found to increase somewhat with increased temperature. None of the eggs used in the 30-day test spoiled.

Fresh eggs are preserved in a number of ways which may, for convenience, be grouped under two general classes: (1) Use of low temperature, i.e., cold storage; and (2) excluding the air by coating, covering, or immersing the eggs, some material or solution being used which may or may not be a germicide. The two methods are often combined. The first method owes its value to the fact that micro-organisms, like larger forms of plant life, will not grow below a certain temperature, the necessary degree of cold varying with the species. So far as experiment shows, it is impossible to kill these minute plants, popularly called "bacteria" or "germs," by any degree of cold; and so, very low temperature is unnecessary for preserving eggs, even if it were not undesirable for other reasons, such as injury by freezing and increased cost. According to a recent report of the Canadian commission of agriculture and dairying:

"When fresh-laid eggs are put into cold storage with a sweet, pure atmosphere at a temperature of 34 deg. F. very little, if any, change takes place in their quality. The egg cases should be fairly close to prevent circulation of air through them, which would cause evaporation of the egg contents.

"Eggs should be carried on the cars and on the steamships (at a temperature of) from 42 degs. to 38 degs. When cases containing eggs are removed from the cold-storage chamber, they should not be opened at once in an atmosphere where the temperature is warm. They should be left for two days unopened, so that the eggs may become gradually warmed to the temperature of the air in the room where they have been deposited, otherwise a condensation of moisture from the atmosphere will appear on the shell and give them the appearance of sweating. This so-called 'sweating' is not an exudation through the shell of the egg, and can be entirely prevented in the manner indicated."

It is stated by Siebel that in practice in this country 31 to 33 deg. F. is regarded as the best temperature for storing eggs, although some American packers prefer 31 to 34 deg., while English writers recommend a temperature of 40 to 45 deg. as being equally satisfactory. The amount of moisture in the air in the cold-storage chamber has without doubt an important bearing on this point. Eggs are generally placed in cold storage in April and the early part of May. If placed in storage later than this time they do not keep well. They are seldom kept in storage longer than a year. Eggs which have been stored at a temperature of 30 deg. must be used soon after removal from storage, while those stored at 35 to 40 deg. will keep for a considerable time after removal from storage, and are said to have the flavor of fresh eggs. The author cited states that eggs for market, especially those designed for cold storage, should not be washed. Stored eggs should be turned at least twice a week, to prevent the yolk from adhering to the shell.

Eggs are sometimes removed from the shells and stored in bulk, usually on a commercial scale, in cans containing about 50 pounds each. The temperature recommended is about 30 deg. F., or a little below freezing, and it is said they will keep any desired length of time. They must be used soon after they have been removed from storage and have been thawed.

The substances suggested and the methods tried for excluding air conveying micro-organisms to the egg, and for killing those already present, are very numerous. An old domestic method is to pack the eggs in oats or bran. Another, which has always had many advocates, consists in covering the eggs with lime-water which may or may not contain salt. The results obtained by such methods are not by any means uniform. Sometimes the eggs remain fresh and of good flavor, and at other times they spoil. Recently, in Germany, twenty methods of preserving eggs were tested. The eggs were kept for eight months with the following results: Those preserved in salt water, i.e., brine, were all bad, not rotten, but unpalatable, the salt having penetrated the eggs. Of the eggs preserved by wrapping in paper, 80 per cent were bad; the same proportion of those preserved in a solution of salicylic acid and glycerin were unfit for use. Seventy per cent of the eggs rubbed with salt were bad, and the same proportion of those preserved by packing in bran, or covered with paraffin or varnished with a solution of glycerin and salicylic acid. Of the eggs sterilized by placing in boiling water for 12 to 15 seconds, 50 per cent were bad. One-half of those treated with a solution of alum or put in a solution of salicylic acid were also bad. Forty per cent of the eggs varnished with water glass, collodion, or shellac were spoiled. Twenty per cent of the eggs packed in peat dust were unfit for use, the same percentage of those preserved in wood ashes, or treated with a solution of boric acid and water glass, or with a solution of permanganate of potash were also bad. Some of the eggs were varnished with vaseline; these were all good, as were those preserved in limewater or in a solution of water glass. Of the last three methods, preservation in a solution of water glass is especially recommended, since varnishing the eggs with vaseline is time consuming, and treatment with limewater sometimes communicates to the eggs a disagreeable odor and taste.

Many of these methods have been tested at the agricultural experiment stations in this and other countries. The Canada Station found that infertile eggs kept much better than fertile eggs when packed in brine. In view of the fact that preservation has been said to injure the eggs by giving them an unpleasant, salty taste, experiments were recently made at Berlin University to learn the proportion of salt which entered the eggs when placed in brine of varying strength. It was found by the investigator that with a saturated or half-saturated solution, the salt entered the eggs at first very quickly, and later much more slowly. After remaining 4 days in the saturated solution, an egg contained as much salt as one which remained 4 to 6 weeks in a 1 to 3 per cent solution. If kept in the saturated solution 4 weeks, 1.1 per cent salt was found in the yolk and 1.5 per cent in the white of the eggs. None of the eggs tested were spoiled. When a 1 to 5 per cent solution was used, the eggs kept well for 4 weeks and did not have a salty flavor. These instances are sufficient to show that any given method will give different results in different hands, and this is not surprising, since the eggs used are not always uniformly fresh, nor is it at all certain that other experimental conditions are uniform.

In the last two or three years the method of preserving eggs with a solution of water glass has been often tested both in a practical way and in laboratories. The North Dakota Experiment Station has been especially interested in the problem. In these experiments a 10 per cent solution of water glass preserved eggs so effectually that "at the end of 3½ months eggs that were preserved the first part of August still appeared to be perfectly fresh. In most packed eggs, after a little time, the yolk settles to one side, and the egg is then inferior in quality. In eggs preserved for 3½ months in water glass, the yolk retained its normal position in the egg, and in taste they were not to be distinguished from fresh store eggs. Again, most packed eggs will not beat up well for cake making or frosting, while eggs from a water glass solution seemed quite equal to the average fresh eggs of the market."

Water glass or soluble glass is the popular name for potassium silicate or sodium silicate, the commercial article often being a mixture of the two. The commercial water glass is used for preserving eggs, as it is much cheaper than the chemically pure article which is required for many scientific purposes. Water glass is commonly sold in two forms, a sirup-thick liquid, of about the consistency of molasses, and a powder. The thick sirup, the form perhaps most usually seen, is sometimes sold wholesale as low as 1¾ cents per pound in carboy lots. The retail price varies, though 10 cents per pound, according to the North Dakota Experiment Station, seems to be the price commonly asked. According to the results obtained at this station a solution of the desired strength for preserving eggs may be made by dissolving 1 part of the sirup-thick water glass in 10 parts, by measure, of water. If the water glass powder is used less is required for a given quantity of water. Much of the water glass offered for sale is very alkaline. Such material should not be used, as the eggs preserved in it will not keep well. Only pure water should be used in making the solution, and it is best to boil it and cool it before mixing with the water glass. The solution should be carefully poured over the eggs packed in a suitable vessel, which must be clean and sweet, and if wooden kegs or barrels are used they should be thoroughly scalded before packing the eggs in them. The packed eggs should be stored in a cool place. If they are placed where it is too warm silicate deposits on the shell and the eggs do not keep well. The North Dakota Experiment Station found it best not to wash the eggs before packing, as this removes the natural mucilaginous coating on the outside of the shell. The station states that 1 gallon of the solution is sufficient for 50 dozen eggs if they are properly packed.

It is, perhaps, too much to expect that eggs packed in any way will be just as satisfactory for table use as the fresh article. The opinion seems to be, however, that those preserved with water glass are superior to most of those preserved otherwise. The shells of eggs preserved in water glass are apt to crack in boiling. It is stated that this may be prevented by puncturing the blunt end of the egg with a pin before putting it into the water.

In the East Indian Archipelago salted duck eggs are an article of diet. The new-laid eggs are packed for 2 or 3 weeks in a mixture of clay, brick dust, and salt. They are eaten hard-boiled. It is said that in this region and in India turtle eggs are also preserved in salt. These products, while unusual, do not necessarily suggest an unpleasant article of diet. The same can hardly be said of a Chinese product which has often been described. Ducks' eggs are buried in the ground for 10 or 12 months and undergo a peculiar fermentation. The hydrogen sulphid formed breaks the shell and escapes, while the egg becomes hard in texture. It is said that the final product does not possess a disagreeable odor or taste. Eggs treated in this or some similar way are on sale in the Chinese quarter of San Francisco, and very likely in other American cities. A sample recently examined had the appearance of an egg covered with dark-colored clay or mud.

Selling Eggs by Weight.—Since eggs vary more or less in size it has been proposed that they should be sold by weight rather than by the dozen, which is the usual custom in this country. The North Carolina Experiment Station, in investigating this point, recorded the weight of eggs per dozen and the number produced during six months by pullets and old hens of a number of well-known breeds and by ducks. Generally speaking, larger eggs were laid by hens than by pullets of the same breed. The eggs laid by Pekin ducks (old and young) averaged 35.6 ounces per dozen, and were heavier than those laid by any breed of hens. Of the different breeds of hens tested the largest eggs weighed 28 ounces per dozen, and were laid by Light Brahmas. The Black Langshan and Barred Plymouth Rock hens' eggs weighed a little over 26 ounces per dozen, while those laid by Single Comb Brown Leghorns, late hatched Plymouth Rock, White Wyandotte, and Buff Cochin hens ranged from 21.7 to 23.7 ounces per dozen.

Of the pullets, the heaviest eggs (weighing 26.5 ounces per dozen) were laid by the Black Minorcas, the lightest by the Single Comb Brown Leghorns and Silver-Laced Wyandottes. These weighed 17.5 and 22.1 ounces per dozen, respectively. The Barred Plymouth Rock, White Plymouth Rock, White Wyandotte, Black Langshan, and Buff Cochin pullets' eggs all weighed not far from 24 ounces per dozen. As will be seen, the variation in the weight of the eggs was considerable. In tests carried on at the Maine Experiment Station it was noticed that eggs from hens that laid the greatest number were on an average smaller in size than those from hens producing fewer eggs. The percentage of fertility was also less in the former than in the latter.

In the North Carolina test all of the eggs, regardless of size, had a local market value of 13½ cents per dozen at the time of the investigation. If a dozen Single Comb Brown Leghorn pullets' eggs weighing 17½ ounces were worth 13½ cents per dozen, or 12 cents per pound, the eggs of the other breeds would be actually worth from 16.3 cents for the Single Comb Brown Leghorn hens to 21.6 cents per dozen for the Light Brahma hens, or from 20.7 to 60 per cent in excess of their market value. The eggs of the Pekin ducks would be worth 26.7 cents, or 97.8 per cent above their market value. On the basis of the results obtained, the station advocates selling eggs by the pound instead of by the dozen. It is said that the egg packers and dealers maintain that this method would increase the cost of the eggs, owing to the extra handling necessary and the consequent breakage. An apparent objection to selling eggs by weight is that they are not generally used in the household in this way. Most recipes call for eggs by number and not by weight. There is no question that weighing the eggs would be more accurate, and recipes are occasionally met with in which this method is followed.

Desiccated Eggs, Egg Powders, and Egg Substitutes.—Different methods of evaporating or desiccating eggs have been proposed and several products which claim to be prepared in this way are now on the market. It is said that the egg is dried in or out of a vacuum, usually by a gentle heat or by currents of air. When placed on the market the dried egg is usually ground. Sometimes salt, sugar, or both have been used as preservatives. Such material is merely egg from which the bulk of the water has been removed. If the process of manufacture is such that the resulting product is palatable and keeps well, the value of evaporated eggs under any circumstances is evident.

This material is used by bakers to some extent as being cheaper when fresh eggs are high in price. It is also used in provisioning camps and expeditions, since desiccated foods have the advantage of a higher nutritive value in proportion to their bulk than the same materials when fresh. Fresh eggs contain about 25 per cent of dry matter. If all the water is removed in preparing evaporated eggs, 1 pound will furnish nutritive material equivalent to about 4 pounds of fresh eggs. One of the commercial egg products recently tested appeared to be dried egg coarsely ground. For use it was thoroughly mixed with a small quantity of water. The mixture could then be fried or made into an omelet, etc., and was found to be very palatable, closely resembling in taste the same dishes made from fresh eggs.

An egg substitute has been manufactured from skim milk. It is said to contain the casein and albumen of the milk mixed with a little flour, and is put up in the form of a paste or powder. Such material is evidently rich in protein and, according to reports apparently reliable, is used in considerable quantities by bakers and confectioners in place of fresh eggs.

Egg substitutes have been devised which consist of mixtures of animal or vegetable fats, albumen, starch or flour, coloring matter, and some leavening powder in addition to the mineral matters similar to those found in the egg. Such products are designed to resemble eggs in composition.

Other egg substitutes have been marketed which contain little or no albumen, but apparently consist quite largely of starch, colored more or less with some yellow substance. These goods are specially recommended for making custards and puddings similar in appearance to those in which fresh eggs are used. There is no reason to suppose that such products cannot be made so that they will be perfectly wholesome. The fact must not be overlooked that in the diet they cannot replace fresh eggs, since they do not contain much nitrogenous matter or fat. As recently pointed out in one of the medical journals, this may be an important matter if such an egg substitute is used in the diet of invalids, especially if the composition of the egg substitute is not known, and it is employed with the belief that, like eggs, it contains an abundance of protein.

Importance of the Egg Industry.—The egg industry is of considerable commercial importance. The total number of eggs produced in the United States in 1890 was estimated to be 820,000,000 dozen, and these figures are quite often said to be too low. The United States formerly imported a large number of eggs and exported very few. The ratio has changed within the last ten years, and now the exports largely exceed the imports.

Growth of the Egg Industry.—In 1890 the total number of eggs exported was in round numbers 381,000 dozen, worth $59,000; in 1899, 3,694,000 dozen, worth $641,000. In 1890 this country imported 15,000,000 dozen, which were valued at $2,000,000, and in 1899 only 225,000 dozen, valued at $21,000.

Taking into account the five years up to and including 1898, 61 per cent of the exported eggs were sent to Cuba, 20 per cent to Canada, and 11 per cent to Great Britain, while the remainder was distributed among many other countries. During the same period, 96 per cent of the eggs imported came from Canada, 3 per cent from China, and the remainder from various other countries.

These statistics of the egg trade are of interest, since they show the great growth of the poultry industry, and indicate what it may become in the future. Some of the developments may be fairly attributed to the work of the Government and the agricultural experiment stations. For many years a considerable number of the stations, especially those in Alabama, California, Indiana, Kentucky, Louisiana, Maine, Massachusetts, Michigan, New York, North Carolina, North Dakota, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, and West Virginia, have been experimenting upon methods of feeding and caring for poultry, the comparative value of different breeds, the possibility of increasing egg production by proper feeding, and the selection of laying stock, and similar problems. The station bulletins reporting the investigations have been circulated widely. These investigations are being continued and promise to be even more valuable in their results in the future than in the past. The Department

of Agriculture has done much to encourage the poultry industry by collecting and distributing information,* and in other ways.

Poultry raising is often carried on in conjunction with general farming, and may be profitably developed along such lines. When it is followed as an independent enterprise, its possibilities are also great. There is always a market for poultry and eggs for food, while the raising of fancy stock for breeding purposes is frequently worth consideration.

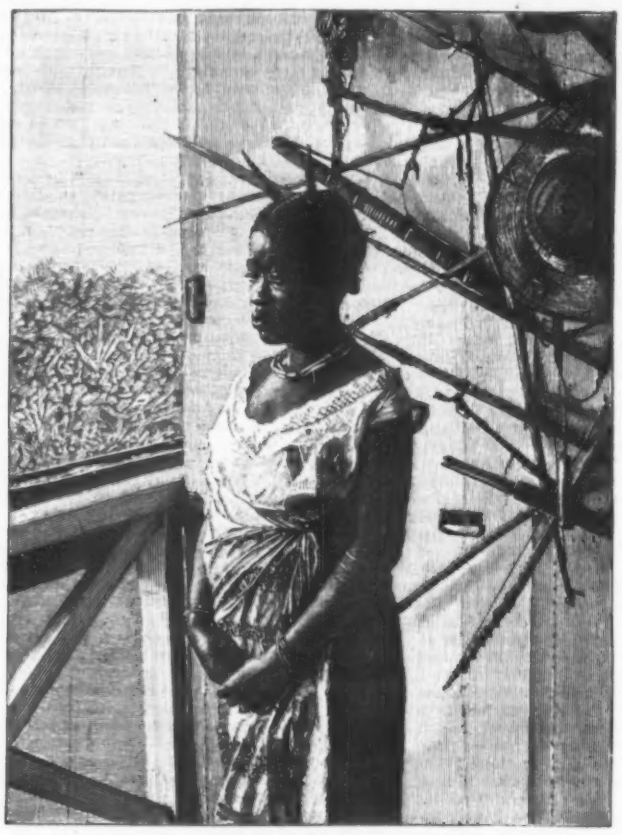
THE GERMAN COLONY OF TOGO.

ON the fifth of July, 1884, the German flag was hoisted over the little fishing-village of Bagida, in Lower Guinea, amid the booming salutes of the German cruiser "Möve." After the internecine warfare for the throne had been brought to an end, the colonial capital, which had been established at Bagida, was removed to the town of Ahneko. The town of Ahneko is situated on a ramified lagoon, and for that reason it has ever been of no small commercial importance. In December, 1885, a tariff treaty was concluded with the neighboring French colony of Dahomey, which did much to increase the already thriving trade of the region. At first, it is true, the merchants were compelled to confine their activity to the coast. Not until 1890 was an attempt made to penetrate the Hinterland and to bring to the coast the rubber and ivory which so richly abound in the interior. These first expeditions to the Hinterland started out from the town of Lome, for the many arms of the lagoon placed Ahneko at a decided disadvantage. With the beginning of commercial relations with the interior, the town of Lome developed with marvelous rapidity. Factories and dwelling houses sprang up; streets were laid out, and a highway was built to the Hinterland.

The rapid development of Lome induced the imperial government in 1897 to move the seat of the colonial government to that town. Perhaps the government authorities were induced to make the change for sanitary, as well as for commercial reasons, for the town of Lome is healthfully and beautifully situated. Broad, palm-flanked streets, fountains and public drinking places and a narrow-gage railway have given Lome the appearance of a beautiful provincial city. The Johann-Albrecht Platz, situated in the middle of the city, serves as a sort of public mart, for there the bushmen carry the chief articles of export—cocoanuts, palm oil, etc. Every fourth day is market day. Black "clerks" purchase these natural products and send them to the factories, where they are prepared for export. The factories employ chiefly Croo boys, most of whom are Liberians, who collect together in small groups numbering about thirteen, governed by a headman, and bind themselves to a factory for a year. The Croo boys are almost indispensable to the merchants on the coast. Familiar with the sea from childhood, they guide their heavily-laden boats through the heavy surf. Often it happens that a boat becomes the plaything of the elements and is tossed about like a cockleshell upon huge foaming waves. Often the Croo boys are glad enough to escape with their lives.

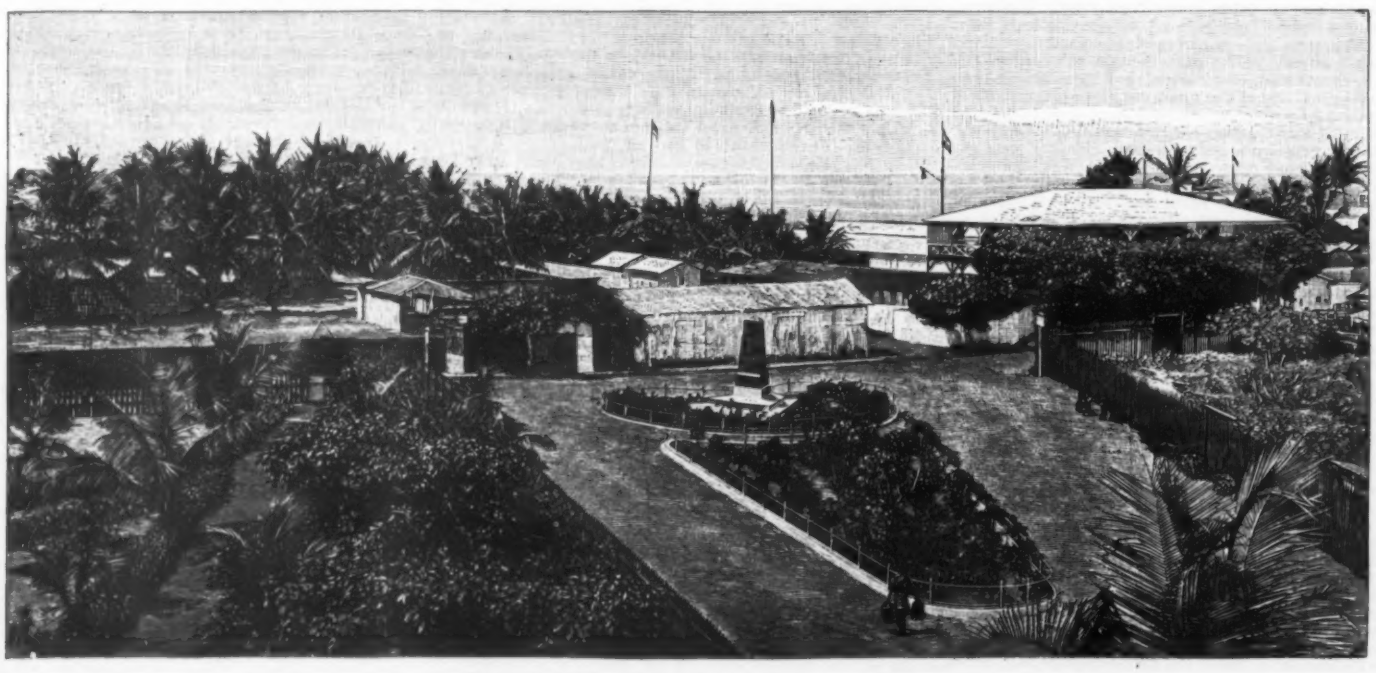
One of the most attractive streets in the town of Lome is Market Street (Marktstrasse), lined with the huts of the natives, who sit before them offering food and utensils for sale. The shops of the Europeans are also to be found on each side of the street. The European wares have an irresistible attraction for the simple minds of the natives. The motley-colored headcloths and fabrics, the shining silks and soft velvets of the whites are highly prized. The natives show no little taste in arraying themselves in this foreign splendor. Every black mother considers it her duty to heighten the charms of her chocolate-colored baby by tricking it out in clothes of many colors. The Togo belles usually clothe themselves in a white overgarment trimmed with lace and a brightly colored breech cloth ornamented with strips of silk or velvet. The costume, falling in rich folds to the naked feet, displays to the best advantage the rich, full forms of these native girls. Sometimes a native beauty will try to give herself a more slender form by the use of a European corset.

Although the men of Togo care more for rum, gin and liquors, for flintlocks, guns and powder, they have also, to a certain extent, adopted European dress. On Sundays, when the church bell tolls, the Christian population appears on the streets, a bright, moving picture of many colors. Clad in a long black coat, upon his



A WOMAN OF LOME.

WOMAN AND CHILD OF THE TOWN OF LOME.



A PUBLIC SQUARE IN THE TOWN OF LOME.

* Farmers' Bulletins 41, 51, and 64 of the Department are devoted exclusively to poultry topics. A number of Farmers' Bulletins of the series entitled "Experiment Station Work" contain short articles on poultry, poultry feeding, or similar topics. A bibliography of poultry literature has been published by the Department Library (Bul. 18). Bulletin 5 of the Division of Publications contains a list of references to articles on eggs and poultry in the Department publications. A number of the publications of the Bureau of Animal Industry contain articles on poultry diseases, egg production, and other topics, while many of the publications of the Section of Foreign Markets give statistics of the poultry and egg industry.

head a silk hat which has lost much of its pristine gloss, his woolly hair impudently combed out at each side, his neck imprisoned in a "choker," the black dandy proudly struts along, seizing every opportunity to admire himself in the shop windows.

But the best customers of the factories are the natives of the interior, who, in contradistinction to the aborigines of the coast, clothe themselves in a loose shirt, trousers, burnouse, and turban or fez. Formerly these men came to the coast from the great markets of the interior, from Kratji, Jendi, and Salaga, in order to exchange ivory and rubber, and even horses and cattle, for European wares. These traders have done much for the development of Lome. The entire quarter of the city now reserved for them is called the Haussa quarter. The small round huts of woven grass or matting and the narrow, dirty streets offer little to attract the eye. But the inhabitants of the quarter themselves are far more interesting than their dwellings. The men as well as the women are distinguished by their strength, their proud carriage and their exceptional intelligence. These Haussa merchants are ardent Mohammedans. In the early morning hours the voice of the muezzin or public crier may be heard calling the Faithful to prayer.—A. Diehl in Illustrirte Zeitung.

LAUNCHING A BOAT IN THE SURF.

SOME ADVANCES MADE IN ASTRONOMICAL SCIENCE DURING THE NINETEENTH CENTURY.*

In glancing over the field of astronomical achievement during the century recently closed, the most striking feature is undoubtedly the rise and growth during the past fifty years of an entirely new department, one totally unknown and almost undreamed of before the first half of the century had passed, that called by Prof. Langley the new astronomy, more technically known as astrophysics. In considering the restrictions which must be regarded in case this address is to be kept within manageable limit, perhaps it would be well to confine my remarks to this new branch of the science. I shall, however, give the chief place to the older astronomy, touching briefly upon the newer phase.

HAUSSA TRADER IN NATIONAL COSTUME.

THE HAUSSA MUEZZIN OF LOME.

Near the close of the seventeenth century appeared Newton's immortal work, called by him "The Mathematical Principles of Natural Philosophy." In this treatise the law of universal gravitation as the controlling and governing principle of the planetary system was established by a rigorous course of mathematical reasoning. It was many years, however, before these conclusions were universally accepted. On the continent of Europe particularly, the field was already occupied by the philosophy of Descartes. The glittering generalities found here in place of the severe mathematical reasoning of Newton proved too attractive to be at once overthrown.

Fifty years elapsed before anything material was added to the science of Newton; then came a galaxy of distinguished men, including Euler, Clairaut, D'Alembert, Lagrange and Laplace, who, by a series of most brilliant and exhaustive researches, made possible by the development of much more powerful mathematical instruments than those possessed by Newton, practically disposed of every objection which the opponents of Newton's theory could discover.

Their last stronghold, and one which proved extremely difficult to carry, was the explanation of the secular acceleration of the moon's motion. Halley, one of Newton's disciples, had found by a comparison of ancient and mediæval eclipses with those of modern times, that the lunar month is now shorter than was the case two thousand years ago. How this could be, if the motion of this body were governed by the law of gravity only proved an extremely difficult question. It was finally shown by Laplace to be one of the consequences of this law, that what is now an acceleration will in the future become a retardation, thus preserving the system essentially as we see it to-day. This took place near the beginning of the nineteenth century. We may, therefore, say that this century began its course with the law of universal gravitation firmly established. In fact, no one was hereafter found to seriously call it in question whose opinion was worthy of notice.

It is not to be supposed, however, that the science of celestial mechanics was now finished. In fact, we can hardly say that any branch of physical science ever has been or ever will be finished. Results depending for their value upon observations of any kind must share the inevitable imperfections of the observer and of his instrument.

The problems of celestial mechanics have accordingly

MARKET STREET IN THE CITY OF LOME.

* Annual address delivered before the University of Pennsylvania Chapters of the Society of Sigma Xi, June 13, 1901, by C. L. Doolittle.—From Science.

occupied the attention of a large number of distinguished men during the century past. With the discovery of new planets and comets and stellar systems, new applications are constantly appearing calling for the most refined skill and active perseverance of its votaries. Refinements in observation and improvements in method also call for frequent revision of the old investigations. This is particularly true of the lunar theory.

The study of the moon's motions was one of the first problems to attract the attention of the ancient astronomers. Since their day we are probably safe in saying that no problem in the entire range of science has called out anything approaching the labor and ingenuity bestowed upon this one. Yet the theory is hardly in a satisfactory condition to-day. Such a statement may seem to those who have never looked into the intricacies of the problem like a confession of failure.

So far as it concerns a purely mathematical statement of the conditions the problem offers no difficulties. The relations between the co-ordinates of a body like the moon, acted on by any system of forces, are very readily expressed by a series of three differential equations of the second order. The forces here are the mutual attractions exerted by the sun, moon and planets. If only two bodies are present, the solution offers no difficulty. If there is a third, we have the famous problem of the three bodies. In spite of all that has been done during the century in the way of mathematical advancement this problem still defies its most powerful resources. Recourse must be had to methods of approximation, expansion in the form of series being one of the most obvious. No one can form an idea of the intricacy and complexity of the resulting expressions who has not himself looked into the problem. Delaunay, at one time director of the Paris Observatory, carried this investigation farther than any of his predecessors had done, but though it had occupied his almost undivided attention for twenty

CROO BOY (LIBERIAN) FACTORY HAND.

years, it was still unfinished at the time of his death. (He was unfortunately drowned at Cherbourg in 1872 by the capsizing of a pleasure boat.) We have in this country to-day three investigators who are perhaps the greatest living authorities on this subject—Profs. Newcomb, Hill of New York, and Brown of Haverford.

The general problem of three bodies has proved a very fascinating one. If, for instance, Mars and Jupiter were of approximately the same dimensions as the sun, the determination of their respective motions would be vastly more complex than it now is. Mr. G. H. Darwin has been giving much attention to this class of problems bringing out some interesting results. Although the problem does not confront us in this unmanageable form in our own system, it will eventually find practical application in unraveling the intricacies of the stellar motions.

Probably no achievement in the domain of science ever produced so profound an impression upon the unprofessional public as the discovery of Neptune by a purely theoretical investigation undertaken independently by Leverrier and Adams, predicting its place in the heavens before it had ever been seen, or at least recognized as a planet. It is unnecessary now to rehearse the familiar story of that brilliant discovery. It was somewhat like the egg of Columbus, but up to the present time the attempts to apply the process in other regions of the planetary system have not been attended with success. The first such attempt was by Leverrier himself, followed in 1859 by his confident announcement of a planet between Mercury and the Sun. The prestige of Leverrier's name, accompanied by a supposed view of the planet by Dr. Lescarbault, an amateur astronomer, proved sufficient to carry conviction generally; and Vulcan found a place with the other planets in many books written thirty or forty years ago. No one else, however, whose authority was worth much claimed to have seen the planet until the occurrence of the total eclipse of the Sun July 29, 1878. At this time Prof. Watson, of Ann Arbor, and Lewis Swift, of Rochester, believed they had each seen one and perhaps two planets near the Sun. The reputation of both as skilled observers naturally gave great weight to their authority, but the planets were never seen again, and a critical examination of the places assigned renders it practically certain that fixed stars were mistaken for planets. Vulcan as a single large planet within the orbit of Mercury is now, by the unanimous verdict of the astronomical profession, relegated to the realm of myths. It was very natural to attempt to apply the process to the discovery of planets beyond Neptune, but although some indications of one and possibly two such have been suspected, nothing of the kind has yet been seen.

The eighteenth century ended with a list of known planets numbering seven, not including satellites. The nineteenth began with eight, the first day of January, 1801, being distinguished by the addition to the list of Ceres, the first of the long line of asteroids to be detected. The fortunate discoverer was Gieuseppe Piazzi. The scene of Piazzi's activities was the University of Palermo, where he had been diligently engaged for nine years with the most perfect instrument which the skill of that day could produce in accumulating materials for a great stellar catalogue. At the time of which we are speaking his attention was directed to a place in the constellation Taurus on account of an error of Wollaston, one of his contemporaries, in assigning a place to a star where none existed. Piazzi found, however, an eighth-magnitude star not before noted, and upon repeating the observation the following evening it was found to be in motion. Piazzi carefully followed the planet until February 11 when he fell ill, and his activities were for some time suspended. Meanwhile letters had been sent to Oriani, at Milan, and Bode, at Berlin. About this time, however, it may be remembered that another individual, not wholly unknown to fame, was actively employed in this part of the world in the practical applications of military science. We refer to one Napoleon Bonaparte. This may explain the fact that Oriani's letter arrived at Milan two and one-half months after it was written. Olbers, however, received that directed to him at the end of two months. The planet was now lost in the sun's rays, and it was greatly feared that it would not be recovered, for, with a body so minute, unless its position could be given with some approach to accuracy the attempt to find it was an almost hopeless task. This emergency brought to the front the great mathematician, Gauss. At that time a young man unknown to fame, he attacked the problem, and as a result produced a method for determining an orbit from three observed positions, which completely overcame the difficulty, at the same time showing its author's title to a place in the front rank of mathematicians.

The discovery of three more planets belonging to the asteroid group soon followed—Juno, Vesta and Pallas. Then, after a long interval, came Astræa, in 1845. The discoverer was Hencke, an amateur astronomer, who had been watching the heavens during fifteen years in the hope of this reward. The number now known to exist is near five hundred, with no indication that the supply approaches exhaustion. About ten years ago the application of photography to this purpose by Wolf, of Heidelberg, made possible what may be called a wholesale process. One plate, taken October 22, 1900, showed no less than five of these bodies. This is at present believed to be the maximum record. What is to become of this numerous family is one of the serious questions of this day. The complete investigation of the theory of one is almost the work of a lifetime.

Of satellites, or secondary planets, seven have been added to the list during the century: one of Saturn, by Bond, of Cambridge, September, 1848; one of Neptune, by Lassell, soon after the discovery of the planet itself; two of Uranus, also by Lassell, 1851; two of Mars, by Hall, of Washington, August, 1877; one of Jupiter, by Barnard, of the Lick Observatory, September, 1892. We should perhaps include an eighth in this category, an additional satellite of Saturn having been announced by W. H. Pickering two years ago; but, as it has not yet been confirmed, judgment must be suspended for the present.

The periods of rotation of Mercury and Venus were investigated by the German astronomer Schroeter, sometimes called the Herschel of Germany, near the beginning of the century. His conclusion was that the length of the day on both these planets differs but little from our own. These results kept their places in the text-books almost unchallenged until near the close of the century. The multiplicity of observers equipped with instruments greatly superior to those of Schroeter were apparently unable either to confirm or disprove his conclusions. In 1889, however, Schiaparelli found what he considered decisive evidence showing that the planet Mercury rotates on its axis in the same time required to complete a revolution about the sun, thus like our moon always keeping the same hemisphere presented to the primary body. Later Schiaparelli came to the same conclusion with regard to Venus. The results obtained at Flagstaff, Arizona, by Messrs. Lowell and Douglas are in perfect agreement with these conclusions. Although probably correct, the question is still regarded by many as an open one. The spectroscope will give the final verdict. Attempts in this direction have already been made by two experienced spectroscopists, Keeler, at the Lick Observatory, and Belopalski, at Pulkowa. Keeler's career was closed by death, leaving this and many other important researches unfinished. Such references to Belopalski's results as have come to our notice seem to throw but little additional light on the question. It may be that the instrument has not yet reached that degree of mechanical perfection which an investigation of such delicacy demands but we may confidently predict its ultimate success.

With regard to the rotation periods of Uranus and Neptune, we know next to nothing. Such scanty bits of information as have been obtained, however, point to short periods in both cases, 8 to 12 hours; here again we may look to the spectroscope to give us a final answer.

As to the physical condition of the planets themselves, their adaptability to the support of animal and vegetable life, we certainly know a little more now than was known during the early part of the century. The author of the "Positive Philosophy" expresses what seems to have been the prevailing sentiment regarding the orthodox science of that day as follows: "With regard to the heavenly bodies, we may obtain practical knowledge of their geometrical and mechanical phenomena, but all physical, chemical, physiological and social researches for which our powers fit us on our own earth are out of the question in regard to the planets. The only case in which this rule may be too severe is in that of the temperature."

There was, however, no dearth of philosophers whose speculations disregarded these modest limitations. To such the planets, like our own earth, were the abode of vegetable and animal life with, of course, intelligent beings, perhaps greatly superior to ourselves, at the head. As no other use in the economy of the universe could be suggested for these neighboring worlds, and as God could not be supposed to create anything in vain, the conclusion was obvious. More exact knowledge has, however, dissipated most of these plausible theories. It seems at present unlikely that a single one of the other planets, with the possible exception of Venus, can now be in a condition to support the higher forms of life.

It is not now proposed to enter into a discussion as to the indications of the existence of intelligent beings on the planet Mars. Though there are some who assert with great confidence that such is without doubt the case, there are others whose opinion is of equal value who are certain that the last Eskimo was frozen to death on the planet's equator many thousands of years ago. As to the large planets, Jupiter, Saturn, Uranus and Neptune, on account of their great size and consequently slower development, it is certain that they have not yet reached a condition adapted to the support of life, unless it be in its lowest forms. There is every indication that a very high temperature exists in the case of all four of these planets, that they are largely gaseous, consisting to a great extent of vapors floating in atmospheres whose depth must be reckoned in thousands of miles, and that certainly no part of the solid nucleus is ever seen by us.

We have every reason for believing that the sun with the attendant planets, our earth included, had a common origin, that they are composed of the same materials, that the same chemical and physical laws prevail throughout the system. We may feel very confident also that the same combinations of physical and chemical conditions which on this earth are associated with organic life will be similarly associated on other planets; that those conditions which prevent this development except in its lower forms above the line of perpetual snow will act in the same manner on Mars or Venus.

At the beginning of the century one comet was known to be a member of our system, more than one appearance having certainly been observed, viz., that of Halley. This comet is famous historically as the first whose return was successfully predicted, thus completely demolishing the vague and absurd notions which had been held regarding these bodies. At the close of the century something like a score have been observed at more than one appearance, one of which, that of Biele, has certainly gone to pieces, with many indications that a like fate is in store for all. Closely associated with the subject of comets is that of meteors, a subject to which the attention of all of us has been more or less directed within the past two years by the amount of space which the journals have given to the expected appearance of the November displays. This department of astronomy was quite unknown to science a hundred years ago. In the early part of the century writers who condescended to mention meteors at all spoke of them as atmospheric phenomena. As for meteoric stones, specimens of which are seen in all mineralogical collections, scientists would have none of them. Learned academicians ridiculed the idea that any one should be so absurdly credulous as to admit the possibility of a ponderous

stone falling from heaven. When in 1790 an official statement signed by three hundred eye witnesses of such an event was sent to the French Academy, one of the distinguished physicists of that body wrote concerning it: "How sad it is to see an entire municipality certifying in a formal official document to the truth of a fable which can only be regarded with pity." Finally, in 1803, occurred a fall in France of so conspicuous a character and attested by such a host of credible witnesses that it could no longer be treated as a childish fable. The matter was investigated by the Academy with naturally only one possible verdict. Since then much attention has been given to this subject, but it does not appear that any part of it was shared by the minute shooting stars, with the appearance of which every one was so familiar, until the great display of 1833 had drawn attention to them. It soon began to be discovered that records of similar occurrences at various past times were to be found, and finally Prof. Newton, of Yale, in 1864 brought together a series of such historic notices extending back to the year 902, October 15. It was found that these could be represented as successive recurrences of the same phenomenon at intervals of 33 years. Prof. Newton, therefore, predicted with much confidence a repetition in 1866. This prediction was fully verified.

The details of the investigation, by which this was shown to be due to a swarm of meteoric bodies, of average dimensions, probably not much exceeding a grain of sand, moving in a long procession about the sun with a period of 33¼ years, we cannot enter into now. The length of the stream was found to be such that about three years were required to pass the point of intersection with the earth's orbit. In fact, the particles are scattered—very thinly for the most part—over nearly the entire path.

Precisely how it came about that the display was so meager in 1899 is uncertain. Perhaps it was caused by the particles being very unequally distributed along the line and that the earth on that occasion passed through a comparatively thin region. Perhaps the perturbations of the planets have changed the course of the stream to such an extent that the earth no longer encounters it. The question will doubtless receive an answer in due time.

A large number of these meteoric streams have been recognized. A list of 695 radiants, as they are called, is to be found in the Monthly Notices, R. A. S., for 1895. Probably, however, a considerable number of these are fictitious.

One of the most remarkable discoveries connected with this subject was announced in 1866 by Schiaparelli, viz., that the well-known August swarm of meteors moves in practically the same orbit as a bright comet seen in 1862, known as Tuttle's comet. Shortly afterward the orbit of the November swarm was identified with that of Temple's comet of 1866. A number of other such coincidences have been found, the most remarkable being that of a swarm known as Andromedes, which appears to have taken the place formerly occupied by Biele's Comet, in short to be nothing more or less than the shattered fragments of that body. Whether, on the one hand, those streams which have not been identified with any known comet are also the remnants of such a body long since disintegrated, and, on the other, whether those comets permanently attached to our system are undergoing a like process of dissolution, we cannot say with certainty, but the theory looks very plausible. One such catastrophe has been carried to completion within the memory of many now living.

Another case in which this process was rapidly developing was that of the great comet of 1882, which many of us will remember. As this body receded from the sun its nucleus was broken into seven distinct fragments which gradually separated farther and father from each other, until the body disappeared from view. According to the best determination of its period, this comet should return in seven or eight hundred years. When it does return, if this ever happens, undoubtedly it will be in the form of at least seven distinct comets, following each other at intervals of perhaps several years. Each of these will very likely be again subdivided, the operation continuing until nothing remains but minute fragments.

We may follow the process backward as regards this body. In 1843 appeared a splendid comet whose orbit was remarkable on account of the nearness of its approach to the sun. Again in 1880 a large body of this kind appeared whose path so closely resembled that of 1843 that it was generally believed to be the same body, though how such a conspicuous object could return to our neighborhood every thirty-seven years and never have been seen before 1843 was a puzzling question. Greatly to the surprise of astronomers, the great comet of 1882 was found to follow almost precisely the same path. The theory was at once advanced that on account of the close approach of this body to the sun, passing as it did through millions of miles of the solar corona, the resistance encountered was rapidly bringing it into the sun. A few years, possibly a few months, would suffice for completing the work. What effect this collision would produce upon the sun could only be conjectured. Would it bring disaster to our earth or not?

The comet, however, pursued its way after passing the sun with no appreciable change in the character of its orbit. It was followed from September 3, the date of its discovery, until the following June, when its distance from the sun was 470,000,000 of miles. Abundant material therefore existed for investigating its movements. The result was that at least 650 years must elapse before its return, the time being more likely to be 800 years. It seems almost certain, therefore, that the three comets which appeared respectively in 1843, 1880 and 1882 originally constituted one gigantic body, which, on the occasion of a previous visit, perhaps about the time of the Norman conquest of England, had been torn in pieces by the sun's action precisely as was the case with the fragment which returned in 1882.

Whether the meteoric stones of which mention has been made are in any way related to the minute shooting stars, and whether or not they also at one time formed constituent parts of comets, we cannot say with certainty, but there seems to be no clear line of demarkation between the two classes of bodies. It appears to be simply a difference of dimension. A few of the fragments are massive enough to make their way through the air, and are known as meteoric stones. The great majority are so small that they are dissipated in the upper regions of the atmosphere.

On July 8, 1842, occurred a total eclipse of the sun, the line of totality passing over central and northern Europe. Great interest in this event had been aroused, largely due to the enthusiasm of the English astronomer Francis Baily. What we may call the first of the series of eclipse expeditions, since become such a conspicuous feature, were sent out at this time. Among those who made the long journey—long for those days—were the Astronomer Royal, Baily, Struve from Poulkova, Schumacher from Altona, and Arago from Paris. Though the corona and solar prominences had been frequently seen and described in a casual manner by previous witnesses of similar phenomena, such accounts had attracted little attention. Apparently most of the observers on the present occasion were totally unprepared for the spectacle which confronted them. So far as it concerns the cause of science, these now familiar appendages of the sun may be said to date their discovery from this occasion. Baily is particularly eloquent in his account of the corona, closing as follows: "Splendid and astonishing, however, as this remarkable phenomenon really was, and although it could not fail to call forth the admiration and applause of every beholder, yet I must confess that there was at the same time something in its singular and wonderful appearance that was appalling; and I can readily imagine that uncivilized nations may occasionally have become alarmed and terrified at such an object, more especially at times when the true cause of the occurrence may have been but faintly understood, and the phenomenon itself wholly unexpected.

"But the most remarkable circumstance attending the phenomenon was the appearance of three large protuberances, apparently emanating from the circumference of the moon, but evidently forming a portion of the corona. I never lost sight of them when looking in that direction, and when the first ray of light was admitted from the sun, they vanished with the corona altogether and daylight was instantaneously restored."

The importance of these phenomena was now for the first time brought home to astronomers, and the desirability of investigating their true character. A variety of theories were advanced, some old and some new, some not far from the truth and others very much so. Prof. Von Felitsch, of Griefwald, published a treatise in which he proved to his own satisfaction that corona, prominences and chromosphere were purely optical appearances.

Some of the mists and haze enveloping the subject were cleared away by the eclipse of 1851, which was successfully observed in Norway and Sweden, but it was not until 1860 that the true character of these phenomena, that of solar appendages, was firmly established. This occasion marked an important epoch in this class of investigations from the fact that photography was now for the first time generally applied. The photographs possessed the great advantage of freedom from personal bias and of forming a permanent record which could be studied at leisure. Although nothing was previously known of the character of the rays with which the impression must be taken, as it happened the results were eminently satisfactory. The comparison of plates taken hundreds of miles apart showed identically the same forms, thus disposing of the notion that they were due to personal or atmospheric causes, while those taken at the same place, in close succession, showed the moon to pass over them, gradually covering or uncovering them as the case might be.

The eclipse of 1868 was distinguished by another great advance in the practical application of the spectroscope. Now for the first time the true character of the so-called prominences was demonstrated, viz., that of glowing gases or vapors shooting up to heights of fifty or a hundred thousand miles above the sun's surface, and composed in great part of hydrogen. A conspicuous line was also seen near the D line of sodium. As this corresponded to no chemical element then known, it was called the helium line. In 1895 helium was discovered in a gas obtained from the mineral cleveite, an interesting case of a chemical element first discovered in the sun.

In connection with this eclipse it was found that these prominences could be observed at any time when the sun was visible by a proper use of the spectroscope. This important discovery was hit upon independently by M. Janssen and Mr. Norman Lockyer. Both discoverers communicated their methods to the French Academy, the letters reaching the secretary within a few minutes of each other. In commemoration of this event a medal was prepared bearing the effigies of both Janssen and Lockyer.

The principle employed in obtaining the images of the prominences is as follows: The light of these objects is largely monochromatic. If such a ray is passed through a prism it is bent out of its course, losing a little of its brightness by the absorption of the glass, but not otherwise. The light due to the glare of the atmosphere, however, which is the cause of our inability to see these features whenever the sun is visible, being composed of all the colors of the spectrum, is dispersed and rendered so faint as not to interfere with the image of the prominence. The higher the dispersion, the darker is the background against which this image is seen. It was at first thought necessary to employ a narrow slit, thus gradually building up the prominence by taking narrow slices in succession. It was soon found that the slit could be opened wide enough to show the entire image at once. This discovery made possible the careful and deliberate study of this feature of the sun, with the result that more is probably known of it than could ever have been ascertained, had it been necessary as at first to employ only the few moments during total eclipse.

The next step in advance would seem to be in the direction of accomplishing for the corona what had been done for the prominences and thus make possible the study of this feature of the sun's environment under the same leisurely and deliberate conditions. This problem has received a great amount of attention during the past twenty years. Various methods of attack have been suggested and tried, but so far without success.

In 1882 Prof. Huggins believed that he had solved the problem. By the use of plates sensitive only to the most prominent rays of the corona, he obtained photographs which had every appearance of being genuine pictures of the solar appendage. The results were regarded by many as genuine, while others doubted. Much discussion followed, some of it slightly fervid in temperature.

However, the test was simple as soon as an opportunity could be had for applying it. The eclipse of 1886 gave the wished-for opportunity. Photographs taken during totality were compared with those taken by Huggins's process, but alas! the results were far from identical. The supposed coronal forms were therefore fictitious.

Though much in the way of detail has been learned of the corona in connection with recent eclipses, it still remains very much of an enigma. Unless some new method may be found for attacking the problems which it presents, apparently their complete solution will be long delayed. Here, too, as in other cases, the solution of one problem is likely to suggest a score of new ones, so that eclipse expeditions seem unlikely soon to be exclusively things of the past.

At the opening of the century, it can hardly be said that astronomers were in possession of more than two or three catalogues of stars which would be of any use whatever for the exact astronomy of to-day. Even these were of quite limited extent as regards the number of stars contained. There were, it is true, a number of such catalogues based upon the imperfect methods of the previous century, and a considerable amount of valuable material in the form of unreduced observations existed, but the latter was of little practical service so long as it remained in this form. Even if accessible, which was not always the case, very few could undertake the drudgery of searching through the records for the wished-for material, and when found, if found at all, to apply the reductions necessary to prepare it for practical use. It is to George Biddel Airy, who became Astronomer Royal in 1835, that astronomers owe the introduction of the present practice of reducing and publishing observations promptly, thus making them accessible to all.

The most valuable series thus buried out of sight at the beginning of the century was that of Bradley. The observations were made at Greenwich between the years 1750 and 1762. These were first rendered accessible by Bessel, who in 1818 published under the title "Fundamenta Astronomiae," a catalogue of 3,112 stars constructed from all Bradley's observations. More recently a re-reduction has been published by Auwers, in which every refinement which the present state of science could suggest has been employed, in order to obtain from them the best possible results. This catalogue is of special value in such investigations as involve the stellar motions, the remoteness of the time of observation—140 to 150 years—being a great advantage in this respect. There was also a great mass of observed star places, the result of the untiring industry of LaCaille, D'Agelet and Lefrançaise Lalande, nephew of the more widely celebrated astronomer. Most of this material was only placed in an accessible form after the nineteenth century was far advanced, the last contribution being the publication by our own Dr. Gould, in 1864, of the final reduction made under his direction of the observations of D'Agelet, all reduced to the epoch 1800.

The beginning of the century found Piazzi busily engaged at his observatory in Palermo accumulating material for his famous catalogue of 7,646 stars, which finally appeared in 1814. As he possessed for this purpose an instrument superior to anything previously constructed, and was himself a careful and most industrious observer, this catalogue has been of very great value. A re-reduction of the observations is now in progress, based upon the more accurate values of the constants which we now possess, and with improvements in method unknown one hundred years ago, which cannot fail to add greatly to its usefulness.

As time went on observations were conducted with more or less regularity at various places, each observer or institution acting independently of what was done elsewhere. As a result, many stars were observed over and over again, and others, equally important, not at all. In 1866, however, the Astronomische Gesellschaft of Germany organized a systematic campaign, having for its object the accurate cataloguing of all stars of the northern heavens not fainter than the 9th or 9.5th magnitude. For this purpose the entire northern heavens were divided into zones of about 5 degrees in width, and thirteen different observatories each undertook to observe one, or in some cases two, of these zones, the work all being done on a strictly uniform plan, so that the results shall be homogeneous throughout. This work has been in progress for more than thirty years—somewhat deliberately at some places, it must be said, but is now nearly completed. The plan has since been extended to include southern stars as far as the tropic of Cancer. Meanwhile our own distinguished countryman, Dr. B. A. Gould, as the result of fifteen years' labor at Cordoba, Argentina, has given us a similar catalogue of 73,160 stars between the tropic of Cancer and the south pole.

The great work, instituted by the Astronomische Gesellschaft in 1865, is still unfinished, yet an even more ambitious undertaking was inaugurated fourteen years ago by an international congress assembled at Paris for that purpose. This calls for a photographic survey of the heavens to be participated in by a number of observatories—eighteen have joined in the undertaking—two sets of plates being taken. The first set are to have sufficient length of exposure to give positions of all stars not fainter than the eleventh magnitude. These are to be measured and the resulting positions catalogued. When completed, this catalogue will include between two and three million stars. The second series of plates is to have a longer exposure, sufficient to show stars of the fourteenth magnitude and will furnish charts of the heavens—22,154 plates are called for and many years will be required for their completion. The results already obtained show that star positions may be obtained in

this way with an accuracy little if anything inferior to the results of meridian observation.

The problem of the past history and future destiny of the solar system has occupied much attention during the century. Near its beginning Laplace had announced his famous nebular hypothesis. For many years it seems to have been taken for granted that little if anything could be added to this theory. In a general way it may be said that it forms the foundation of whatever has been developed in this direction. Laplace began with the sun already existing, surrounded with an atmosphere of heated vapor extending beyond the farthest planet. This body revolved on its axis and gradually shrunk as its heat was radiated into space. The linear velocity of the outer parts remaining constant, the angular velocity would constantly increase until in time the centrifugal force became equal to the centripetal when the central part separated, leaving the equatorial part in the form of a ring. This ring contained the material out of which the outermost planet was formed. Successive repetitions of the process produced the different planets, and these in turn produced satellites in the same manner. The rings of Saturn were held to be almost an unanswerable piece of evidence in favor of the theory. Though, without doubt, the system was evolved in some way from a primitive nebula, we may say with certainty that it did not follow the orderly course marked out for it by Laplace. The subsequent discovery of the great principle of the conservation of energy dispensed with the original hypothesis which started with the mass in a heated condition, at the same time that it associated with it the important question as to the supply of heat and other forms of energy which are constantly being poured out with such prodigality by the sun. If we suppose the matter composing our system to have been at one time a nebulous mass, filling the present orbit of Neptune, the temperature may then have corresponded to the absolute zero so far as our purposes are concerned. The process of shrinking and condensation to the present condition would have evolved an amount of heat quite equal to that which the problem calls for, but, unless a constant supply is furnished from some source, the present process of radiation will soon come to an end. The explanation of this supply which is generally accepted was first announced by Helmholtz in 1854. He ascribed it to the shrinkage of the sun now going on. It is capable of mathematical proof that a body consisting of matter in the form of a gas, which is the case with the sun, by the process of condensation due to the pressure produced by its own attraction, will constantly grow hotter so long as it remains a gas. This operation must end when a considerable portion of its matter is reduced to a liquid or solid form. The system, then, had a beginning, and as a consequence it must come to an end. Or more properly speaking the present condition of things cannot last forever. Thus Helmholtz concludes that if the intensity of radiation has been uniform from the beginning, the present order cannot have existed longer than 22,000,000 years. Others make the period less. Looking into the future, at the end of 5,000,000 years, the sun will have contracted to half its present volume, and at the end of another 5,000,000 years it will be mainly if not entirely solid, and must have ceased to be self-luminous much earlier. An interesting corollary to this subject is the principle of tidal evolution developed by Mr. G. H. Darwin. Supposing the moon to have been separated from the earth by some process at a time when the matter composing them was in a liquid condition, each body would produce enormous tides in the other. Consider those produced on the earth by the action of the moon; the effect would be on the one hand to retard the earth in its rate of rotation, and on the other to drive the moon farther from the earth. Without going further into detail, we may say that Mr. Darwin finds that if no other causes were at work not less than 50,000,000 years would be required for the evolution of the system of the earth and moon as it now exists.

It was not far from the beginning of the century that Herschel attempted the solution of the greatest of all problems—that of the structure of the universe. The problem proved, as may be supposed, quite impossible of solution by methods then available. Much has been learned during the century which was unknown to Herschel, but we seem to be as far as ever from the final solution. Instead of an orderly distribution of stars, clusters and systems, we find all apparently intermingled with vast cosmic clouds and huge dark bodies, possibly burned-out suns. For anything we know these latter may be as numerous or more so than the brilliant ones. Will the labor of another century bring order out of this seeming confusion, or will it only disclose still greater complexities unknown to us? Time alone can tell.

FIG. 1.—THE PAIMPAREY MATTRESS BOAT.

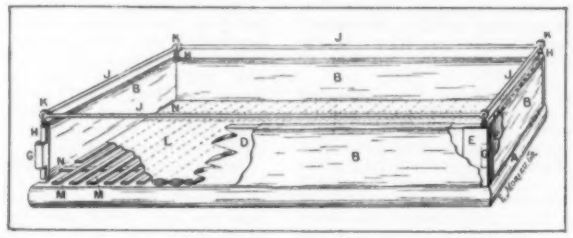


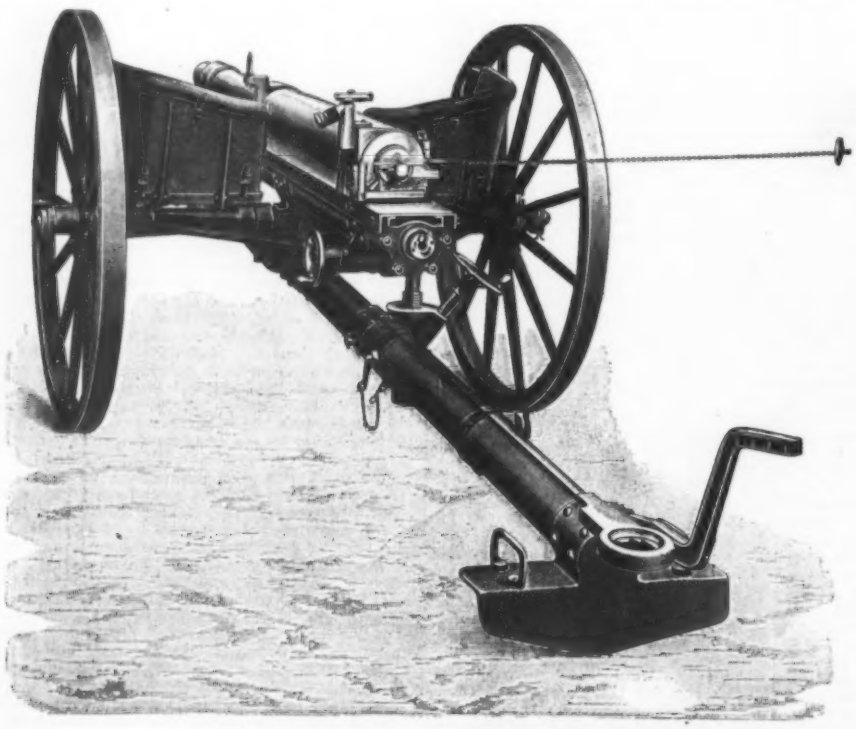
FIG. 2.—DETAILS OF CONSTRUCTION.

A FIELD-PIECE WITH A TUBULAR CARRIAGE.

So far has the modern rapid-fire machine gun been developed that it is almost impossible to make the utmost tactical use of its possibilities. To the use of fixed ammunition and by the invention of more effective breech-blocks, we owe the rapidity of fire in modern field guns. Improvements have, however, been made not only in the gun mechanism itself, but in the carriage as well. It has been the purpose of the improved carriages which are now being introduced to reduce the time required in aiming the piece, and so to check the recoil that the range will not be lost.

Most gun-carriages are provided with spades, which, buried in the ground, offer considerable resistance to the recoil. The spade-carriage is undoubtedly as simple as can be desired; but its defects are glaring. The checking of the recoil depends largely upon the character of the soil upon which the gun is at the moment located. At the end of a shot or series of shots the gun-crew are compelled to ascertain the range again.

In the new tubular carriages which have lately been introduced in the French and German armies the difficulties encountered in the use of the spade-carriage are very largely overcome. While the piece is in action, the tubular carriage is immovable. A pebble placed on the upper portion of the rim of one of the wheels will not be thrown down during the discharge of a projectile. The carriage consists of upper and lower members. The gun-barrel is carried back into the first member after the discharge. The lower member consists of two telescoping tubes and serves the purpose of counteracting the strain to which the tail of the carriage is subjected. The tubular carriage is likewise provided with a spur, or spade, the efficiency of which, however, is not dependent upon the nature of the soil so much as in the rigid carriage. After the discharge, the gun-barrel immediately resumes its initial position. The usual recoil-cylinders are employed to return the barrel to battery.—Lieut. Hübner, of the German Army, in Illustrirte Zeitung.



FIELD-PIECE WITH TUBULAR CARRIAGE.

A MATTRESS BOAT.

M. PAIMPAREY, needing for the use of his 1.75-ton yacht some sort of a small boat that could be stowed away on board in such a manner as to occupy but little space, conceived the idea of employing for the purpose one of the air mattresses used for lying upon, and, after a number of experiments, succeeded in devising a genuine boat capable of easily carrying two men and rigging. The mattress, after being inflated, forms the bottom of a flat boat of strong canvas. The sides, *B B* (Fig. 2), 8 inches in height, are double and open at the four corners at the exterior only. Through these four openings are introduced boards, *D*, 0.8 of an inch in thickness and provided at each end with a half hinge, *E G*, of copper. When the boards are in place the hinges are assembled by the introduction of a pin, *H*. This done, a mattress for sleeping upon is placed in the interior. This consists of a strong double canvas, *L*, of the same size as the air cushion, and stitched crosswise at equal intervals of 4 inches so as to form sheaths for the introduction of ash slats, *M*. The rigidity lengthwise of this mattress is obtained by fixing upon the two sides a bamboo 1.5 inches in diameter, and which, when in place, is situated between the mattress and air cushion. This boat is maneuvered through a paddle, the center of which is formed of a tube in which engage the two blades, thus permitting the whole to be arranged in a small space.

The hinge-pins at the four corners of the boat terminate in a strong ring, *K*, through which is passed an ash rod, *J*. It is through the latter that the boat is grasped in order to carry it or is maneuvered by chains or ropes in case of shipwreck.

This boat mattress may be used in a general way upon transatlantic or other ships, where it may be employed as an ordinary mattress for sleeping purposes and be placed all mounted upon beds in lieu of spring mattresses in staterooms. In this way, the passengers will have it at their disposal in case of danger and may use it as a lifeboat. It might likewise be used by explorers as an ordinary mattress for sleeping upon. Better still, by mounting the apparatus in

its form of a boat and turning it upside down so that its rigid upper edges may rest upon the earth, there would be obtained a bed elevated above the ground and preventing a contact of the occupant with humid and swampy soil. The explorer would thus have at the same time an insubmergible boat for the crossing of watercourses and rapids. For the above particulars and the engravings we are indebted to La Nature.

THE SERIES ALTERNATING SYSTEM.

Constant Current Transformer.—The desirability of operating enclosed arc lamps in series on alternating current circuits has resulted in the development of a system comprising constant current transformers and series enclosed arc lamps. The primary windings of the transformers are connected directly to single-phase or polyphase alternating current circuits of practically any voltage. The lamps are connected to the secondary winding either all in series on a single circuit or, by means of a multi-circuit connection, divided between two circuits. These transformers have been successfully operated directly connected to voltages as high as 10,000.

Constant Current Transformer Core and Coils.—Constant current transformers are built in standard sizes to operate 25 lights, 35 lights, 50 lights, 75 lights, and 100 lights.

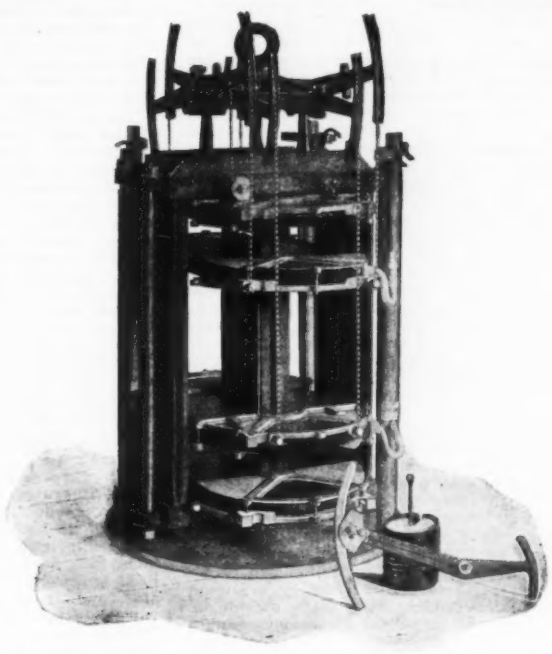
The 25-light and 35-light transformers consist of a core of the double magnetic circuit type with three vertical limbs and two flat coils enclosing the central limb. The lower coil, which is the primary, is fixed in position, while the upper one is carried upon a balanced suspension. The suspended coil moves freely along the central limb of the core. The larger transformers have the same form of core, but have two sets of coils, a set of fixed primary coils at the extreme upper and lower ends of the core and two secondary coils free to move up and down along the central limb of the core.

Suspension of the Coils.—In the two coil transformers, a lever is supported by knife edge bearings on hardened steel tables, which are clamped to the top of the core. One end of this lever is provided with two fixed arcs, from which depend two cables supporting the movable coil. At the outer end of the lever an adjustable arc carries a counterweight by a cable suspension. The amount of counterweight is adjusted to balance the whole weight of the movable coil, less the electrical repulsion due to normal currents in the coils.

In the transformers having two primary and two secondary coils, the movable secondary coils are balanced one against the other by a system of double rocker arms supported on knife edges. The weight necessary to balance the repulsion between the primary and secondary coils is carried on a small auxiliary lever also supported on knife edges.

The adjustable arc on the other end of the lever is provided with a micrometer screw, by means of which accurate current adjustments may be made.

CONSTANT CURRENT TRANSFORMER, COMPLETE.



MECHANISM OF CONSTANT CURRENT TRANSFORMER.

Transformer Case.—The mechanism of the transformer is surrounded by an iron case, providing ample cooling surface. The working parts of the transformer are immersed in oil, which not only acts as an insulator, but assists in conducting away the heat.

Adjustment.—Within the working limits, the mechanical repulsion between the fixed and moving coils of the system for a given position is proportional to the current flowing in the coils. The transformer is therefore adjusted to maintain any current, simply by changing the amount of counterweight.

In the transformers having but one moving coil, the counterweight equals the weight of the coil less the electrical repulsion, and a reduction in the counterweight will produce an increase in the current.

In the transformers, having two sets of moving coils balanced one against the other, the counterweight serves merely to draw the primary and secondary coils together in opposition to the repulsion effect. In this case, a decrease in the counterweight is followed by a decrease in the current.

The arc on the counterweight lever is made adjustable, because the repulsion exerted by a given current flowing in the coils is not the same for all positions of the coils, being greater when the primaries and secondaries are close together and less when the primaries are separated. By means of the adjustable arc, the effective radius of the balanced weight is made to change as the coils move through their working range. When the primary and secondary coils are separated by the maximum distance, the resultant force tending to draw them together should be less than when they are close together.

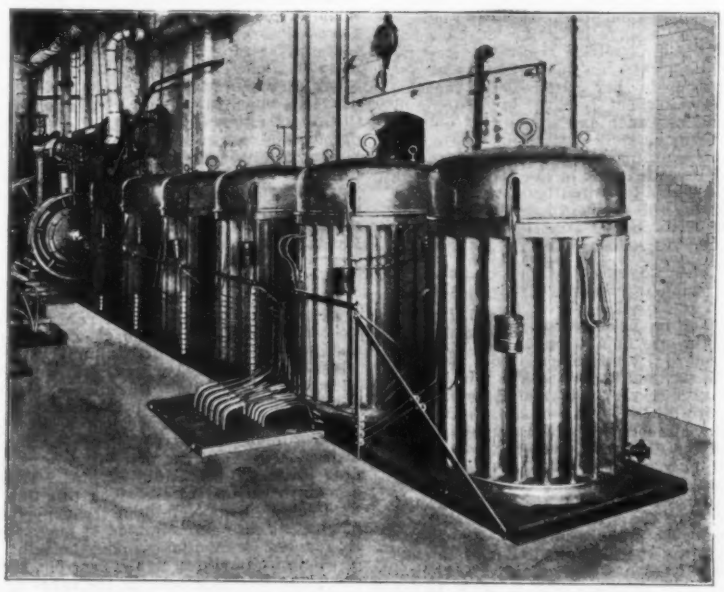
Regulation.—When current flows in the primary and secondary coils, the mutual repelling forces separate the coils until equilibrium is restored. The current corresponding to the position of equilibrium may be adjusted by changes in the counterweights, and the coils will then always take such a position as will maintain that current constant in the secondary coils, regardless of the external resistances to which the coils are connected. With any current less than normal, the repelling force diminishes and the primary and secondary coils approach each other, thus restoring normal current. As soon as the secondary current exceeds normal, the resultant pull exerted by the counterweight and coils is overcome and the secondary coil moves away from the primary, again restoring normal current. Transformers of this design can be made to maintain constant current even more accurately than the constant potential transformer maintains uniform potential.

The transformer will regulate over a range from full load to one-third its rated capacity. If properly adjusted, the current should be within one tenth ampere of normal for any number of lamps between full load and one-third load. The transformers will run several hours on short circuit without excessive heating.

Efficiency.—The efficiencies of constant current transformers with full load of arc lamps vary at 60 cycles from about 96 per cent for the 100-light transformers to about 94.6 per cent for the 25-light transformers. They have comparatively high efficiencies at partial loads with standard lamps.

The power factor of the system is about 76 to 78 at full load with standard differential lamps.

Installation.—The transformers are usually located in the station where the current is generated, although they can be located in sub stations nearer the lines to be operated. No special consideration need enter into the selection of the location excepting that it should allow a free circulation of air around the transformer. No more attention is required after the transformers are started than with any ordinary constant potential transformer.



INSTALLATION OF SIX 50-LIGHT TRANSFORMERS.

TESTING TRANSFORMER.

The connections of constant current transformers with both single circuit and multi-circuits are shown in the accompanying illustrations.

One of the strongest arguments for the constant current transformer system is the readiness with which it may be adapted to the varying requirements of the central station. Transformers can be built to operate on 60, 125 or 133 cycle circuits and for any reasonable primary voltage. There are also a number of special combinations which can be furnished when ordered, and which are of great value to central stations where

a change of voltage, frequency or load is in progress or in contemplation.

Connections for Two Voltages.—In all transformers having two primary coils, these coils are ordinarily connected in series. In order to operate the same load at one-half voltage on the primary, the primary coils may be connected in multiple precisely as would be done with a constant potential transformer. This connection cannot be used with the single circuit transformers since they have but one primary coil. The efficiency and power factor of the transformers are the same whether they are operated with the coils in series or multiple.

Connections for Two Frequencies.—All sizes of the constant current transformer can be built to operate at either one of two frequencies. An extra lead is brought out from each specially wound primary coil, and the transformer is changed from one frequency to the other by a simple change of connections made outside of the transformer. The efficiency and power factor of the transformer on 60 cycles are about the same as the standard. On 125 cycles the efficiency is about the same as the standard, but the power factor is slightly lower.

Constant Current Transformers on Multi-phase Circuits.—The constant current transformer was originally designed to operate on single-phase circuits. It was soon seen, however, that multi-phase installations offered an even greater field for the development of the system. This is particularly true of two-phase and three-phase transmission work where at the sub-station, or at the end of the transmission line, the constant current transformer does the work of a synchronous motor and direct current arc machine.

Central stations using multi-phase generators usually have large units; and here, too, the constant current transformer, often located below the main floor and entirely out of sight, takes the place of high speed motors and arc generators which must be installed on the main floor. On two-phase circuits the standard transformer is used, with equal capacity, as near as may be, connected to each phase. On three phase circuits the same plan may be followed, using three transformers. It is, however, often desirable to operate two transformers on a three-phase circuit. Special transformers can be built in all sizes to meet this condition. They are wound for the well-known three-phase to two-phase transformation, and by a simple change in the primary connections, made outside of the transformer, can be adapted for operation as single transformers on single-phase, two-phase, or three-phase circuits.

Testing Transformer.—A constant current testing transformer to supply current for testing and adjusting arc lamps at the station is very valuable for central stations operating many lamps. The transformer manufactured for this purpose by the General Electric Company has a capacity of six lights, and in electrical and mechanical design is practically identical with the standard 25 light transformer. It is light and does not require the use of a tank or oil, so that a company operating several stations can readily move it from one station to another. Its use tends to keep the lamps in good repair and adjustment, insuring satisfactory service to the city and decreased expense for repairs to the central station.

Our engravings are from "The Series Alternating System," which is furnished complete by the General Electric Company.

CONTEMPORARY ELECTRICAL SCIENCE.*

Velocity of Different Ions.—Previous researches undertaken by D. Child have shown that when a discharge passes between a flame and a neighboring metallic plate, the quantity discharged varies nearly in proportion to the square of the difference of potential and inversely as the cube of the distance. The velocity of the positive ions varies from 2.85 centimeters to 1.45 centimeters per second for a potential gradient of 1 volt per centimeter, and that of the negative ions from 4.66 centimeters to 2.03 centimeters per second. These experiments, showing an average of 25 per cent excess of velocity of negative over positive ions, are in striking contrast to the measurements made with the electric arc, where the positive ions exceed the negative ions in velocity by 100 per cent. Zeleny's method of measuring the velocities of X-ray ions was applied by the author to the arc, and the positive ions again showed double the velocity of the negative ones. The author has since investigated an arc between mercury electrodes through mercury vapor, where no second substance intervenes. The greatest potential gradient was then at the anode, so that the positive ions move fastest. The author makes the interesting proposition that whenever gases are ionized the negative ions move most rapidly, but whenever metallic vapors are ionized the positive ions move most rapidly. This would be an important generalization.—D. Child, Phys. Zeitschr., May 18, 1901.

Discharge by Flame Gases.—On the occasion of an announcement of the destruction of gaseous conductivity by smoking liquids, K. von Wesendonck stated that the conductivity of flame gases depended largely upon the state of the surface of the metallic electrodes to be discharged. The same author has since accumulated further evidence of the importance of the electrode surface, without, however, succeeding in throwing much light upon its nature. A brass plate will show a "fatigue" of its discharge when exposed to sal-ammoniac fumes. This fatigue is not, however, due to the formation of a non-conducting surface layer, as its exposure to acid vapors often has the effect of eliminating the fatigue. Even the influence of water does not seem to be a determining one, since fatigue sets in both when the electrode is moistened and when it is well dried. It is known that ultra-violet light produces some effect upon the surface of the negative electrode, and the author suggests that flame gases may have a peculiar radiation of their own which produces the change of surface conditions described. This recalls the explanation hazarded by J. Chunder Bose. The author also calls attention to the observations of Villari that a charge of electricity of one kind in the interior of a paraffin tube de-röntgenizes gases passing through the tube.—K. von Wesendonck, Phys. Zeitschr., June 1, 1901.

Electromagnetic Properties of the Ether.—As an attempt to clear up the obscurities attached to Maxwell's theory concerning electrostatic phenomena, L. Graetz has formulated a theory which he claims to be free from contradictions, either in itself or with experiments. He assumes the ether to be an elastic solid, and therefore attributes to it the same properties as Fresnel and Neumann did. In ponderable matter the ether experiences an influence which is manifested as a force as soon as there is a displacement in the ether. The force exerted by the molecule upon the ether is manifested in a local change of the density of the ether, while the ether retaliates by displacing the molecule from its normal position. Those parts of a material body in which such a displacement exists permanently are the ions. This action and reaction between the ether and the molecules leads to Maxwell's equations. The so-called magnetic polarizations, or displacements, are determined by the torsion of the ether elements, while the electric forces, all except some electrostatic ones, are the velocities of the ether particles. The magnetic energy of a body is the potential energy of ponderable matter. The electric energy consists of two parts, one of which is the kinetic energy of the ether, whereas the other is the potential energy of ponderable matter. "True" magnetism, assumed to be zero in Maxwell's theory, has no meaning whatever. The magnetic properties of iron may be brought in as special molecular torsions. The so called true electricity consists of the amount of ether contained by a given volume in excess or defect of the normal amount. A current consists in the transformations of rectilinear motions of molecules into heat vibrations. The conception that the ether surrounding every molecule is attached to it implies that a totally independent relative motion of ether and matter is impossible.—L. Graetz, Ann. der Physik, No. 6, 1901.

The Photographophone.—E. Ruhmer has considerably improved his photographophone, and achieved some very notable successes with it. The vibrating flame of an arc lamp is photographed on a kinematograph film, and the sound vibrations are thus translated into dark and bright stripes on the film. The light is concentrated upon the sensitive film by means of a cylindrical lens. When the impression of the voice has thus been taken the film is developed and fixed in the usual way. To reproduce the sound the film is moved past an ordinary projection lamp, and a sensitive selenium cell provided with telephones and a dry battery is placed behind it. The changes in the illumination of the selenium cell produce changes in the current corresponding to the original sound vibrations. The velocity of the film is 2 or 3 meters per second, but even with 20 cm. per second good photophonograms are obtained. From one negative any number of positive films may be obtained, and either the negatives or positives may be used for reproduction. The inventor hopes to record pictures and sounds on the same film. An interesting development proposed is the synthesis of human speech from its elements, obtained from the photophonograms, or from an artificial film suitably shaded.—E. Ruhmer, Phys. Zeitschr., May 25, 1901.

Atmospheric Electricity.—F. Exner concludes his summary of recent investigations in atmospheric electricity with a discussion of the variation with altitude of the fall of potential. All the more recent balloon observations to higher altitudes have shown a decrease in the fall of potential. It appears that the supposed self-charge of a balloon by the friction of its netting is not appreciable. The air is, speaking in general, negatively charged in the lower regions, and positively in the upper regions, but in such a manner that up to altitudes of 4,000 meters the sum of the earth's charge and that of the air remains negative. In clear weather the air exhibits almost always irregular local electrification. Whether the air itself is electric or any ingredient of it, such as water or dust, remains as yet undecided. The author further criticises the theories of atmospheric electricity put forward by Elster and Geitel, Brillouin and Le Cadet, and agrees that neither these nor his own are entirely satisfactory. He recommends the use of recording balloons fitted with polonium collectors for investigations in the higher regions of the atmosphere. These investigations are of special importance for solving the problem as to whether the total charge of the earth and its atmosphere is zero or not.—F. Exner, Terr. Magn., May, 1901.

New Effects of the Continuous-Current Arc.—W. Peukert describes some interesting discoveries made in connection with the speaking arc. He found that acoustic effects could be produced by means of the arc itself without the use of a telephone or a microphone. A condenser of 7.7 microfarads was mounted in parallel with the arc, and contained a key in its circuit. On depressing the key a loud whistling noise proceeded from the arc when it had a certain definite length, say ¾ mm. The length could be varied within narrow limits, and the pitch of the high note emitted then varied accordingly. But as soon as the arc exceeded a certain length the whistling ceased abruptly, setting in again on reducing the arc to its proper length. It appears that the alternate charges and discharges of the condenser produce alternating currents which coalesce with the continuous current of the arc to form a periodic current of 10 to 20 amperes from a continuous current of 6 amperes. The E. M. F. is not sensibly augmented, the value found being about 68 volts. The frequency would be about 10,000 ~ per second. The experiments are important as placing within our reach the production of charge currents of an intensity never yet attained with condensers, and also the production of strong alternating currents of high frequency and low voltage.—W. Peukert, Elektrotechn. Zeitschr., June 6, 1901.

Magnetic Work of Nansen's Expedition.—Part VII. of the "Scientific Results of the Norwegian North Polar Expedition, 1893-96" is devoted to the discussion of the magnetic observations made by Lieut. Scott-Hansen during the voyage of the "Fram." It has been prepared by Prof. Aksel S. Steen, of Christiania. The regular magnetic observations, made while the ship was fast in the ice, were begun on October 7, 1893, and ended July 8, 1896. Observations were made on 194 days at 223 different places, yielding 70 declination, 80 dip, and 99 horizontal intensity results. In addition, there were 60 sets of declination observations, for which no azimuth observations could be obtained, and 48 sets of deflections with the dip circle for determination of relative total intensity. For the first few days a tent was set up on the ice to protect the instruments, but from October 16, 1893, to February 10, 1894, the screwing of the ice prevented its use, and observations were made in the open air, about 80 meters from the ship. After that the tent was again brought into requisition, and was used until November 9, 1894, at which time the instrument was transferred to a snow hut, about 100 paces from the ship. From June to September the tent was again used, being then superseded by an observatory built of blocks of ice, in which observations were made until its downfall in June, 1896. The observations of July 7 and 8, 1896, were made in the open air. Lieut. Scott-Hansen found it necessary to have a revolver or other weapon always at hand as a protection against bears, but he was careful to place it so that the magnets would not be affected. The declination observations are affected by diurnal variations, which was not determined on the spot. To judge from the analogy of the Grinnell Land observations of 1883, the correction should be between 30 minutes and 40 minutes, as the observations were mostly taken in the afternoon. Compared with Schmidt's theoretical values, the magnetic elements show large discrepancies, amounting to −5 deg. to + 10 deg. in declination. But the discrepancies are tolerably systematic, and indicate the absence of strong local disturbing causes. The observations were continued by Nansen and Johansen even on the sledge journey, whenever exigencies of the struggle for existence permitted.—D. L. Hazard, Terr. Magn., May, 1901.

Magnetic Analysis of Radium Rays.—H. Becquerel has improved his method of analyzing radium rays into their constituent forms of radiation. The active substance is placed in a uniform magnetic field. A thin flat sheaf of rays parallel to the field is picked out, and the photographic impression of the rays, some of which are deflected by the field, is received on a sensitive plate normal to the field at nearly grazing incidence. The tracks left upon the plate are arcs of circles, which fuse together to form patches with circular outlines. A suitable disposition of successive screens with slits enables the observer to pick out any circular arc at pleasure. Two screens are necessary, since an infinite number of cylinders could be drawn through the linear source and a slit parallel to it. The undeflected rays are marked by straight tracks. They have the greatest penetrative power, and after traversing glass they traverse aluminium 0.1 mm. thick without suffering any change, and evidently retaining their characteristic value of mv/e. They produce no secondary radium rays, such as are produced whenever the rays are absorbed. The secondary rays produce tertiary rays, and rays of higher orders. They proceed from both surfaces of the material they impinge upon.—H. Becquerel, Comptes Rendus, June 3, 1901.

Physiological Effects of Radium Rays.—All the leading workers on the subject of radium rays have in turn subjected their own persons to some painful experiments for the advancement of their fascinating branch of science. Giesel placed a radium preparation in celluloid case on his arm for two hours. The skin only showed a slight reddening at first, but two or three weeks afterward inflammation set in and the skin came off. P. Curie was the next voluntary victim. He exposed his arm for 10 hours to the deadly rays. On the twentieth day a crust formed, and then a sore, which had to be bandaged. On the forty-second day the skin began to reform, but even on the fifty-second day after the exposure a grayish tract of skin remains to indicate the mortification. H. Becquerel placed a very active radium preparation in his waistcoat pocket for six hours. The resulting sore, which took 10 days to develop, required 39 days to heal. Another sore took 34 days to develop. No action was produced when the tube was incased in lead. Madame Curie underwent experiments of a similar nature. The preparation was in her case inclosed in a thin metallic box, and only applied for half an hour; but the resulting burn took a fortnight to heal. All those who worked with the very active preparations experienced pains and sores in their fingers, which took two months to recover.—Becquerel and Curie, Comptes Rendus, June 3, 1901.

A NEW USE FOR CALCIUM CARBIDE.

Sulphide ores cannot, as a rule, be reduced directly by carbon, but must undergo a preliminary roasting operation to remove the sulphur, the last traces of which are eliminated with extreme difficulty, says The Electrical World and Engineer. Accordingly, when Mourlot directed attention some three years ago to the remarkable stability of calcium sulphide at electric furnace temperatures, the observation was sufficient to direct attention to the possibility of reducing sulphide ores directly by calcium carbide. Early in 1900 an account of investigations along this line was published by Geelmuyden, who found that pyrite, tetrahedrite, galena, stibnite and sulphide of magnesium were readily reduced by calcium carbide, the stable monosulphide of calcium remaining in the crucible, the metals of the ore being liberated and, in the cases of compounds of lead, antimony and magnesium, volatilized. Aluminium sulphide alone proved capable of resisting the powerful reducing agent.

M. Louis Michel Bullier, whose claims as original discoverer of crystalline calcium carbide have been recently upheld by the French courts, now describes an interesting extension of the foregoing principle, whereby the metals are recovered directly from mixed sulphide ores and an efficiency of nearly 90 per cent is obtained. If copper sulphide be fused in presence of a suitable flux for which a blast furnace slag melting, according to the patent, at about 1,500 deg. C. is found available, and calcium carbide added in theoretical proportions, the reduction occurs readily, the calcium sulphide dissolving in the slag and the copper being recovered as an ingot free from sulphur. If copper

* Compiled by E. E. Fournier d'Albe, in The Electrician.

pyrites be subjected to the same treatment it is found that the ingot obtained is composed by two sharply separated layers, of which the lower is copper and the upper iron saturated with carbon. For ores containing zinc or other metal volatile at the temperature used, a closed retort may be employed and the vapors condensed in the usual manner. The reduction of copper pyrites by this method requires an amount of 80 per cent carbide somewhat exceeding the weight of the ore; for copper sulphide the carbide and ore are used in the ratio 1:2.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

New German Fuel.—Under date of June 20, 1901, Consul Hughes, of Coburg, says:

The Imperial German navy and some German manufacturers are using large quantities of "masut" (an oily product of German brown coal tar) for heating and steam-producing purposes. The advantages over coal are stated as follows: (1) The heat-producing qualities of "masut" are said to be one-fourth greater than those of coal; (2) the oil is easier to handle, it being only necessary to open a valve; (3) very little smoke comes from the use of the "masut"; (4) steam can be produced and full power reached in less time. The coast-defense vessels of the German navy are fitted for the use of this oil. Some of the battleships and cruisers are also so arranged that they can use both coal and "masut."

Cultivation of Silkworms in Germany.—Consular Agent Harris, of Eibenstock, June 15, 1901, says that there are several stations in Germany where attempts are being made to raise the silkworm. For many years, continues Mr. Harris, these experiments have not been attended with much success, owing to the severity of the climate. The question of climate, however, is not so applicable to the worm as to the mulberry leaf, and attempts are being made to discover a successful substitute for this plant. In Sprockhovel, near Barmen, experiments are being made in feeding the worms various kinds of leaves and plants, and, according to reports, the results are quite satisfactory. Thirty-two kinds of plants have already been tested, from 100 to 500 worms subsisting upon each; and in Crefeld, during 1900, 120,000 worms were fed with black hellebore, with the result that a silk fiber was obtained, which, however, was greatly inferior in strength and durability to that produced by worms fed upon mulberry leaves.

The Industrial Situation in Germany.—The spring failed to infuse new life into German industry, which has been very sluggish during the last six months. Now that the military operations in the Far East have ceased and the outlook for peace everywhere has become brighter, it is hoped that business will soon improve. Mr. Ballin, the general manager of the Hamburg-American Line, who has just returned from a trip around the world, is endeavoring to arouse hope for the increase of German trade by calling attention to the new markets to be opened in China, especially in the vast and important valley of the Yangtze Kiang. However, the more conservative do not place much confidence in these prognostications. It is pretty generally acknowledged that the present industrial crisis was caused mainly by overproduction in Germany and in other manufacturing countries. Industrial pursuits, as is well known, are dependent one upon the other, and if there is a check in one branch, it is felt elsewhere. Thus, when the textile mills for spinning cotton and woolen yarns are run on short time, but little machinery for such mills will be in demand; when no machinery is built, the iron works shut down; and when no iron is ordered, the coal mines are idle. As soon as one part of the industrial body becomes diseased, the entire system must suffer.

Much is hoped from the commercial treaties now under discussion. I find that, generally speaking, those interested in trade and manufacture in Germany are in favor of long-time commercial treaties, arguing that these would be the best means of removing from the markets of the world the risks brought on by instability and constant changes. In this connection, it is generally stated that the increase of German commerce by about $1,000,000,000 during the past ten years was brought about chiefly through the long-time commercial treaties with other nations.

The coal industry in Germany hoped early in the season to derive great advantages from the export duty which the English government put on its coal. It was expected that this measure would bring on many strikes, thus vastly reducing the output of English coal and increasing the demand for the German article. But these expectations failed to be realized. There is but little demand for coal at present, and the stocks in the coal yards are increasing to an alarming degree. The syndicate has succeeded in keeping up prices fairly well, but it is believed this cannot last much longer. In the iron industry, the difficulties in the main have grown, rather than decreased. It is true some large orders have been placed, and much activity has been shown in certain quarters in order to deliver on time, but such orders were few and they had been kept back to the last moment because everybody knew that they could be filled at once, and by waiting to the last moment there was always a chance of cutting prices. The same condition prevails with the manufacturers of machinery, many of whom have been obliged to discharge their men, while others have had to reduce the time of running their works.

Unusually gloomy has been the condition of affairs in the textile branch of German industry for the past twelvemonth. In a convention of iron men recently held, it was ascertained that in 65 mills in southern Germany, with 37,142 looms, not less than 6,183 looms were idle. It was at once resolved to reduce the output and to induce other districts devoted to spinning and weaving to do the same thing. This has been done, but in spite of all efforts the general situation has not improved. The prices for manufactured goods are dropping and orders are very slow in coming, because everyone feels that he may look for still lower prices. This situation prevails in all branches of the textile industry, including the knitting mills. In some manufacturing towns of Saxony, which had been kept very busy for the past ten years, one-fourth of the looms and other machinery are now idle. In some of the factories for lace curtains, the men work on half time only, and must be content with wages of 8 to 10 marks ($1.90 to $2.38) per week. Even the lace-trimming district in the Erzgebirge is suffering more than it has for years.

The great German industry in chemicals, which for years was exceedingly prosperous, is now beginning to complain of lack of orders and poor prices. The same is true of the large electrical enterprises, which considered themselves beyond the reach of hard times. With the advent of spring, it had been expected that, as is usual at this time of the year, a great impetus would be given to building; but these hopes have also been doomed to disappointment, and thousands of foreign mechanics and laborers, who annually flock to this country at this season, have been compelled to return to their homes. The factories of cement, too, in spite of their abundant capital, have encountered many difficulties, and the failure of the Reichstag to pass the canal bills has not brightened their prospects. The manufacturers of glassware and furniture, in various districts, find it extremely difficult to employ help, even with wages and time much reduced. In consequence of this condition in almost every branch of German industry, many laboring men, especially those with families, barely succeeded in keeping body and soul together; while the monthly reports as to the number of men who are idle and seeking employment are alarming. In addition to all this, Germany must be prepared to harvest the poorest crops it has had in many a year. Altogether, the business situation in Germany is beginning to be very much as it was with us from 1893 to 1897. It is to be hoped that these conditions have already reached their climax. Should they continue much longer, however, it is to be feared that the falling prices, reduced wages, and accumulations of stock will seriously affect our trade with this country.—Henry W. Diederich, Consul at Bremen.

New Method of Construction in the Netherlands.—The Amsterdamsche Fabriek van Cement Yzer Werken has furnished this office with the following description of a new system of construction, which is used in the new Postal Savings Bank Building of this city, now approaching completion:

In the "Monier" system of building, an iron framework (looking much like a bird cage) is entirely enveloped in concrete of Portland cement, which prevents the iron from getting rusty and at the same time renders the concrete elastic. The iron, or rather steel, acts entirely in tension; the concrete in pressure. This construction is at once strong, fireproof, and waterproof, and entails no outlay for repairs.

Patents have been taken out in various countries, and in Germany a joint stock company, with a capital of 2,500,000 marks, has been formed. An establishment of concrete-iron works has been opened in the Province of Zeeland, and another in Amsterdam, at Groote Wittenburgerstraat 108.

This company has made a number of experiments resulting in the application of the ⊥ construction, described as an economic substitute in many cases for T constructions, generally used heretofore.

Floors without beams, measuring 7½ by 7½ meters (24.6 feet) and 8½ by 8½ meters (27.9 feet) have been constructed for the Postal Savings Bank at Amsterdam; and a floor of 300 square meters (3,228 square feet), constructed as a whole (with beams) is about to be made for a government building at The Hague.

Complicated formulæ being required in the calculation of concrete-iron floors and beams, the directors of the company have had some graphic tables drawn up, which enable them to find at a glance the necessary data for the work. These calculations and tables are kept strictly secret.

This system is growing rapidly in favor in all European countries in the construction of government buildings and in manufactories. It is believed that in a comparatively few years it will have replaced brick, wood, iron, etc., in the building trade. The method is specially adapted for bridges.

The "Monier" system will undoubtedly meet with considerable success in the New World, as many tanks, etc., now made of concrete only could be conveniently constructed of concrete iron. The company wishes to extend its operations to America, and desires to cooperate with respectable firms which would be willing to form affiliated establishments.—Frank D. Hill, Consul at Amsterdam.

The Lucas Gaslight.—Consul Winter, of Annaberg, May 30, 1901, says it is claimed that the Lucas light, manufactured by the Deutsche Beleuchtunge und Heiz-Industrie Actien-Gesellschaft, Berlin, can successfully compete with electricity as an artificial light. The apparatus, adds the Consul, is simple, can be attached to the ordinary gas pipe, and may be readily lighted by pulling a wire. The intensity of the light is equal to 500 candlepower. One important feature claimed for it is cheapness, in comparison with electricity.

Commercial School at Cologne.—The Department has received from Consul Barnes, of Cologne, and from Consul Monaghan, of Chemnitz, under date of May 22, 1901, and May 8, 1901, respectively, reports in regard to the new commercial high school at Cologne. The studies comprise science of commerce, knowledge of wares, chemical and mechanical technology, commercial arithmetic, bookkeeping, and correspondence and exercises in foreign languages. The order of study is:

First term.—General political economy, commercial geography of the countries outside of Europe, civil law, and colonial politics.

Second term.—Commercial history up to 1800, civil law; tariff and transportation.

Third term.—Agrarian and trade politics, commercial geography of Europe (including statistics), commercial exchange, and maritime law; trade and social legislation.

Fourth term.—Finances, commercial history of the nineteenth century, international private law, State and Government law, banking, exchange, money, and credit.

Association for Promoting Commercial Instruction.—Under date of June 6, 1901, the Department has received from the International Association for the Advancement of Commercial Instruction (Leonhardstr. 21, Brunswick) the programme and the order of exercises of the constituent meeting at Zurich, on July 11-13 of this year. The United States is requested to send as representatives members of institutions of commercial instruction. Persons interested in the matters of trade and commercial education are invited to become members of the association. The utility of an international association of this nature will be discussed at the inaugural meeting, to be held at Zurich. The universal nature of trade, it is stated, makes it possible for the question of commercial education to be internationally treated in an advantageous manner, as the bases of trade and mercantile requisites are essentially the same in all countries. It is desirable to have an annual statistical review, published in several languages, as well as a central office, to collect the educational plans of various countries and to give information to those interested.

Consumption of Horse Meat in Frankfort.—Consul-General Guenther, of Frankfort, May 15, 1901, says that, according to the Frankfort News of even date, the consumption of horse meat in that city has increased very slowly. The first horse meat dinner was given on October 6, 1847, at Bornheim, a suburb of Frankfort, under the auspices of the Society for the Protection of Animals. As soon as a horse was slaughtered—and at that time only young horses were killed—the society published the fact, and the meat was sold at 6 kreutzers (about 4 cents) a pound. The people did not take kindly to it, however, and it was not until fifty-four years later that the first horse meat restaurant was opened. At the present time about 1,000 horses are slaughtered annually, and a separate slaughterhouse for this purpose has been built.

Denmark's Commerce with Greenland.—Under date of May 8, 1901, Consular Agent Harris writes from Eibenstock:

The exports from Denmark to Greenland are principally food stuffs, firearms and ammunition, woolen goods, implements, and tobacco. Greenland exports to Denmark hides and skins of animals abounding in that region, such as the bear and seal, and whale oil and eiderdown. About 30,000 seal skins are sent to Denmark each year. In 1900, Denmark received 2,600 skins of the blue and white arctic fox, which were assorted and sold in packages of 10 each. The commerce of Greenland is monopolized by the Danish Government. The Royal Danish-Greenland Company has 9 ships—5 brigs (each nearly one hundred years old), 3 barks, and 1 steamer. Ships of other nations cannot touch at the ports of, nor travelers visit, Greenland without the consent of Denmark.

New German Veneer.—Consul Hughes, of Coburg, May 6, 1901, says that a Dresden firm has placed on the German market a thin wooden veneer known as "Kolumbusholz." The veneer is backed with a thick, impregnated paper and comes in rolls 20 meters (66.6 feet) long and about 1½ meters (4.92 feet) wide. When dry, it is very strong and hard. It is nailed to wooden strips on the walls, and has the appearance of handsomely finished wainscoting. The veneer is also shown mounted on very heavy paper or paper mats pressed into different shapes, such as molding for doors, windows, etc. Light artistic effects may also be obtained in window frames, and the like. The prices quoted are from 30 to 50 per cent cheaper than for the all-wood article in use at the present time.

Olive Crop in Southern Europe.—Consul Van Buren reports from Nice, May 7, 1901:

A local newspaper calls the attention of proprietors of olive groves in this district to the diminishing production in Italy, due to the mild winters, the dry spring seasons, and the consequent ravages of the olive fly. It urges the owners of olive plantations in this district to adopt means for their improvement, claiming that better markets will be found on account of the decreased competition from Italy. It omits to state, however, that very much the same condition of things exists here, entire districts being ruined by the black blight or noir, as it is called, while the ravages of the olive fly are an annual occurrence.

Russian Tariff Changes.—The Department has received a note from the Russian embassy, dated Washington, May 26 (June 8), 1901, saying that in view of the imposition of article 626 of the American tariff to Russian petroleum, the Minister of Finance of Russia has applied the advanced rates of duty to the following American products entering Russia: (1) White rosin or colophon, galipot, brewers' pitch (article 82); (2) bicycles (article 173, paragraph 3). This measure will go into effect two weeks after its promulgation.

Portable Houses in Caracas.—The following has been received from Consul Ellsworth, of Puerto Cabello:

There will soon be ready for local occupancy a number of pretty frame residences, manufactured in the United States and shipped in parts. These houses are supposed to be proof against earthquakes.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1093. July 22.—The Cotton Industry of Russia—*Proposed Museum of American Goods at Calcutta—Hungarian Law Respecting Commercial Travelers—*Decline in Price of Russian Petroleum—The Trans-Baikal Railroad—Port Charges in Venezuela—Venezuelan Duty on Tobacco.

No. 1094. July 23.—Production of Cocoanuts and Copra in South America.

No. 1095. July 24.—Automobiles in Europe—Canal Traffic in Germany.

No. 1096. July 25.—New Korean Railway—*An American Box Factory in Japan—The World's Almond Crop—European Raisin Crop—Ship Canals of Russia—*American Coal in Europe—Fruit and Vegetable Exhibit at Moscow—New Russian Duties on United States Goods.

No. 1097. July 26.—*American Trade in Southern China.

No. 1098. July 27.—Exhibition of American Goods at Harput—German East Africa—Proposed Steamship Line between Java and America—Assay Office in Vancouver—Oil of Roses in Bulgaria—Gas Engines in Denmark—Cable Service at Chefoo.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Private Recipes, by Alvin Englehardt, in Neueste Erfindungen and Erfahrungen.

HANDKERCHIEF PERFUMES

1.	Lavender oil	10 grammes
	Neroli oil	10 grammes
	Bitter almond oil	2 grammes
	Orris root	200 grammes
	Rose oil	5 grammes
	Clove oil	5 grammes
	Lemon oil	1 gramme
	Cinnamon oil	2 grammes

Mix with 2.5 liters of best alcohol, and after a rest of three days heat moderately in the water bath, and filter.

2.	Bergamot oil	10 grammes
	Orange peel oil	10 grammes
	Cinnamon oil	2 grammes
	Rose geranium oil	1 gramme
	Lemon oil	4 grammes
	Lavender oil	4 grammes
	Rose oil	1 gramme
	Vanilla essence	5 grammes

Mix with 2 liters of best spirit, and after leaving stand undisturbed for three days, heat moderately in the water bath, and filter.

EAU DE LA LAVANDE.

Bergamot oil	60 grammes
Lemon peel oil	45 grammes
Lavender oil	200 grammes
Rose geranium oil	4 grammes
Oorris root oil	29 grammes
Vanilla tincture	10 grammes
Musk tincture	30 grammes
Rose oil	2 grammes

Digest with 1.5 liters of 90 per cent spirit of wine.

MAYFLOWER SCENT ESSENCE.

Rose essence	30 grammes
Jasmin essence	30 grammes
Cassia essence	30 grammes
Orange flower essence	40 grammes
Violet essence	40 grammes
Vanilla essence	60 grammes

Digest with 3 liters of 90 per cent spirit.

MARECHAL BOUQUET.

Triple rose essence	50 grammes
Simple rose essence	60 grammes
Neroli essence	30 grammes
Civet essence	20 grammes
Iris essence	30 grammes
Tonca beans essence	20 grammes
Rose oil	5 drops
Jasmin essence	60 grammes
Violet essence	50 grammes
Cassia essence	50 grammes
Vanilla essence	45 grammes
Clove oil	20 drops
Bergamot oil	10 drops
Rose geranium oil	20 drops

SEVILLA BOUQUET.

Rose essence	60 grammes
Voilet essence	40 grammes
Jasmin essence	50 grammes
Rose geranium oil (from flower pomades)	7 grammes
Cassia essence	24 grammes
Tuberose essence	50 grammes
Orris root essence	50 grammes

ROSE GERANIUM SCENT ESSENCE.

Rose geranium oil	20 grammes
Violet essence	125 grammes
Cassia essence	120 grammes
Alcohol	3 liters

EAU DE MILLE FLEURS.

Alcohol	10 liters
Orange flower water	4 liters
Neroli oil	120 grammes
Peru balsam	60 grammes
Thyme oil	50 grammes
Musk essence	100 grammes

Mix intimately.

EAU DE MYRTHE.

Alcohol	3 liters
Myrtle water	1 liter
Balm water	0.5 liter
Myrtle oil	300 grammes
Orange flower water	450 grammes
Rose water	500 grammes

EAU DE LACANDE.

Spirit (90 per cent)	2 liters
Lavender oil	160 grammes
Clove oil	10 grammes
Rose water	100 grammes
Musk essence	10 grammes

EAU DE VOILETTE.

Digest 200 grammes of powdered orris root for 8 days with 1 liter of 90 per cent spirit and filter, whereupon add 200 grammes of benzoin tincture.

EAU DE VIOLETTE.

Extrait de violette	1 liter
Rose extract	50 grammes
Jasmin extract	15 grammes
Violet tincture	15 grammes
Musk essence	6 grammes
Rose geranium essence	2 grammes

EAU DE LAIS.

Eau de cologne	1 liter
Jasmin extract	0.5 liter
Lemon essence	0.5 liter
Balm water	0.5 liter
Vetiver essence	0.5 liter
Triple rose water	0.5 liter

EAU DE MERVEILLEUSE.

Alcohol	3 liters
Orange flower water	4 liters
Peru balsam	60 grammes
Clove oil	125 grammes
Civet	40 grammes
Rose geranium oil	10 grammes
Rose oil	1 gramme
Neroli oil	1 gramme

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